PRACTICAL PLANT PROPAGATION

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A field of Empress Narcissus at the U. S. Bulb Gardens, Bellingham, Wash. Note height of the flowers. They come above the knees of Dr. David Griffiths who, when this picture was taken, was supervising the bulb work for the Government.

PRACTICAL PLANT PROPAGATION

AN EXPOSITION OF THE ART AND SCIENCE OF INCREASING PLANTS AS PRACTICED BY THE NURSERYMAN, FLORIST AND GARDENER

By

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PREFACE

A BOOK of this kind necessarily is a record of various opinions covering the ways of propagating plants. It is not a report of a discovery or discoveries, but a compilation of methods. Men have come to realize that every advancement in the art or science of doing things is not only for the benefit of themselves but for the good of all men.

Each book considers the subject matter from a different angle. This book attempts to briefly explain the art and science of increasing plants so that the florist, orchardist, nurseryman, and amateur plant lover may have a guide in the work of properly increasing his stock.

"There is no reason why every farmer, if he so desires, may not propagate all the fruits necessary for his own garden and orchard," writes W. L. Howard. "Such work can be done at little or no expense and, besides, it is pleasant and interesting."

The author acknowledges credit to all who, through their wide experience, have written of plant propagation, and especially to Joseph Meehan* and George W. Oliver,* both pre-eminent in their fields of nursery and greenhouse propagation. Credit is due Dr. L. H. Bailey for crystallizing the scattered information and publishing it in the "Nursery Book" of 1891.

The author welcomes suggestions and advice relating to the subject matter of this book to the end that when a new edition becomes necessary it may have increased value.

ALFRED C. HOTTES.

Columbus, Ohio.

*Deceased

PREFACE TO SECOND EDITION

This second edition is enlarged to include answers to many questions relating to more definite information about propagating plants. Thanks to the excellent notes of A. H. Hill and Marinus Van Cleef, published since the last edition, the propagation of evergreens is more thoroughly covered

Again, the author expresses the hope that he may continue to receive the advice of his readers so that the book may be gradually built to still greater usefulness.

ALFRED C. HOTTES.

Columbus, Ohio.

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Trillow, William
Van Kleef, Marinus
Waid, C. W.
White, Edward A.
Wood, Henry

INTRODUCTORY REMARKS

THE ability to grow and multiply is characteristic of all life. The object of the life of every plant is to perpetuate its kind.

Flowers bloom with color and perfume in order that they may better produce their seeds. Plants spread their stems in the air and their roots in the soil in order to improve their chances in their struggle with the other plants on every hand, and to dominate the earth as much as possible.

Darwin realized this struggle for existence and concluded that every fragrance, color, spine, tuber and adaptation contributes toward the natural ability of the plant to live.

Nature eliminates the weak, overwhelming those that cannot stand the cold or heat, those susceptible to attacks of insect and fungus and those that cannot compete with their neighbors in reproductive powers.

Man shelters his favorites from the cold; improves their natural multiplication; supplies them with proper soil; gives them the environment of their natural homes, or improves upon it; places them on stronger roots and even crosses them to make combinations to meet his fancy. He produces the large fruits and the double flowers at the expense of seed production but he supplies another means of existence for the plant.

Men have noted that when, through accidents, the tops of plants become broken, they often root to form a new individual; how, when roots are cut, often a new plant grows from them; that when clumps of plants are broken up, each part produces a good plant; that trees may rub against each other and be naturally grafted. Men have merely imitated Nature. A careful study of a plant will indicate its method of propagation.

There are two considerations in the propagation of plants: the art, and the science. The art is the craft or ability to multiply plants; the science tells why each operation is done. One is the practice; the other the theory. Each helps the other.

The gardener learns much from doing, but books lead him to see the reasons for his practice.

FEDERAL PLANT QUARANTINE No. 37

On June 1, 1919, there went into effect, Federal Plant Quarantine No. 37, a ruling which has had a profound effect upon the plant industries of our country. America had theretofore depended to a large extent upon the importations from foreign countries of many of its most valued plant materials. The Federal Horticultural Board, believing that foreign pests might be imported to this country, in this stock, devised and imposed this quarantine. At once it struck American florists and nurserymen as being most drastic. It was characterized as too suddenly instituted, as being unwarranted, and as stifling American horticultural progress.

Wise or unjust, the embargo stands. In the five years it has been in force America has partially risen to the occasion; she has started to produce her own plants in some classes formerly imported, she has substituted plants that can be produced in this country for some of those which, although they cannot be (or are not being) grown, are excluded. At present the greatest problems of this sort for America to solve are related to the production of evergreens, Azaleas, Orchids and bulbs, especially Narcissi, which, by the terms of the Quarantine, are not to be admitted after 1925, despite the fact that there is no indication that the domestic supply will then be sufficient for even a small part of the American demand.

ADMITTED PLANT PRODUCTS

(1) Fruits, vegetables, cereals and other plant products imported for medicinal, food or manufacturing purposes.

(2) Field, vegetable and flower seeds.

(3) The following classes of materials which may be brought in, when free from sand, soil or earth from countries which maintain adequate plant inspection, systems under special permits (not including the particular subjects of other special quarantines):

A. Bulbs: Lily, Lily of the Valley, Hyacinth, Tulip and Crocus until further notice; the following nine kinds until December 31, 1925, after which they shall be removed from the list of bulbs permitted unlimited entry; Narcissus, Chionodoxa, Galanthus, Scilla, Ixia, Muscari, Fritillaria imperialis, Fritillaria meleagris, Eranthis.

B. Stocks, cuttings, scions and buds of fruit for propagation.

C. Rose stocks for propagation, including Manetti, multiflora, brier Rose and Rosa rugosa.

D. Nuts, including Palm seeds for propagation.

E. Seeds of fruit, forest, ornamental and shade trees; deciduous and evergreen ornamental shrubs; and hardy perennial plants.

(4) By a subsequent Amendment (No. 1,) it is provided that the requirements as to freedom from sand, soil or earth need not apply to the bulbs permitted to enter (under 3A) if the sand, soil or earth used in packing them is sterilized in accordance with the official methods and requirements, such sterilization to be certified to by an authorized inspector of the country of the shipment origin.

(5) By Amendment No. 2, it is provided that limited quantities of excluded nursery stock, plants and seeds, not the subject of any special quarantine, may be admitted under permit for the purpose of "keeping the country supplied with new varieties and necessary propagating stock." Applications for such permits must satisfy the authorities as to the essential value of the plants involved and the need of the quantities specified. Plants imported under such permits must pass through the hands of the Department of Agriculture and successfully pass an inspection made by it, all entry and transportation charges to be paid by the importer.

THE EXCLUDED PLANTS

Except for the plants and seeds above mentioned the law requires that when any sorts are to be admitted the importer shall first apply for a permit.

Enforcement of this Quarantine, interpretation of its terms, etc., are in the hands of the Federal Horticultural Board, made up of five members of existing bureaus of the U. S. Department of Agriculture, not more than two members to come from any one Bureau. This Board is appointed by the Secretary of Agriculture under the terms of the original plant Quarantine Act of August 20, 1912.

HOW TO IMPORT PROPAGATING STOCK AND NOVELTIES

If you desire to import any novelty or stock for propagation (under special permit) write to the Federal Horticultural Board, Washington, D. C., for a copy of Application Form 207. Upon this you will be asked to state the number of plants desired, the necessity for importing them, the purpose for which they will be used, and where and how they will be grown. If the application is approved you will be required to sign a personal liability agreement binding yourself to carry out the exact purposes for which you say you desire the stock; after which the permit will be forthcoming. You must then forward to the party from whom the plants are being secured the permit tags supplied by the Board to be affixed to the material covered by the permit.

GENERAL INDEX

INDEX OF PLANT NAMES

INDEX TO ILLUSTRATIONS

SUPPLEMENTARY BOOK LIST

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CHAPTER I

SEEDS

PLANTS NOT BREEDING TRUE FROM SEED—GERMINATION—Vitality—Longevity—Longevity Tables—Testing Seeds—TIME TO SOW—SOIL FOR SEED SOWING—POTS AND FLATS—LIGHT—SUGGESTIONS—Depths—Firm Soil—SOWING FINE SEEDS—WATERING—TIME REQUIRED—GERMINATION TABLE—GERMINATION RATE AND QUALITY OF BLOOM—SEED SIZE AS RELATED TO VALUE—SPECIAL GERMINATION TREATMENTS—1, Covering with Burlap—2, Soaking—3, Filing—4, Stratifying—5, Scalding—6, Acids and Alkalis—SOWING PERENNIALS—AQUATICS—CACTUS—FLORIST'S SEED TIME TABLE—Time Table for Vegetable Seed Sowing—SHRUB AND TREE SEEDS—CONIFERS FROM SEED—Collecting Cones—Yield from Cones—Cutting Test—Treatment of Seed—Time to Sow—Soil—Protection by Windbreaks—Preparing Soil—Size of Seed Bed—Making Seed Bed—Sowing Seed—Shade—Watering—Thinning—Damping-off of Conifer Seedlings—BROAD-LEAVED EVERGREENS—DIŒCIOUS PLANTS—SAVING SEED FROM DESIRABLE PLANTS—POLLINATION OF TOMATOES—POLLINATION OF CUCUMBERS.

PLANTS exist in order to produce their seeds; some die immediately after finishing this process. Seeds are entire plants in an embryonic stage and are so micrified that the oak tree is within the acorn.

The labor of seed production by a plant is trying and, when seed is not wanted, it is better to relieve the flowers of the necessity of producing their seeds by picking the blooms as they pass their maturity.

Good looks are not always indicative of the ability of seeds to produce superior plants. Hidden within the sexual constitution of the seed is the secret of its real value.

It is the superior ancestry of the plant rather than the individual value of a single seed that counts. Baldwin Apples may produce good seed but these do not produce good Baldwin Apples. Many of the poor relation parents show up when the seeds are sown. In the same manner seeds from the blue Lobelias will often produce progeny with blue flowers of varying hues. Such hybrid plants whose parentage is much complicated and whose characteristics are not fixed must be propagated by other methods.

THE GERMINATION OF SEEDS

Whether a seed sprouts or not depends on four factors: water, air, heat and viability, or the ability to live. Each seed has its proper or optimum moisture, atmospheric and temperature requirements. For example, Mistletoe seed will germinate on the trunks of trees where the conditions are often very dry. For seed germination, ordinary outdoor flowers require a temperature of from 50° to 70°, conservatory plants from 60° to 80°, and tropical or stove plants from 75° to 95°.

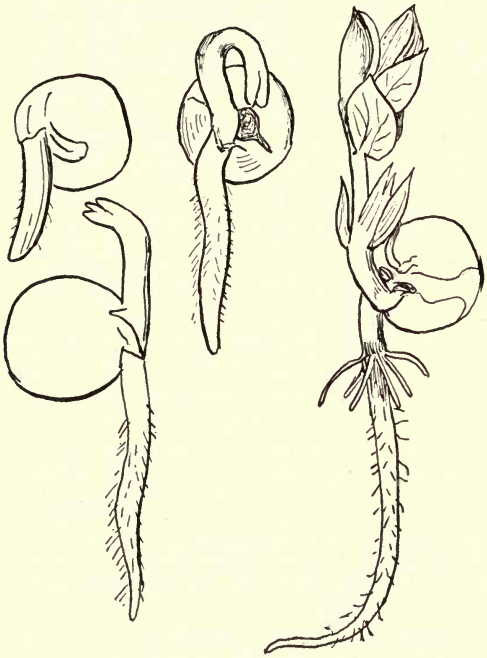

Fig. 1.—Pea seedlings

The viability of a seed depends upon a great number of factors. Seeds if immature when gathered are not so viable; they will germinate better immediately after picking than when stored for some time. Pansy seeds mature in such a way that only some of the seeds are perfectly ripe at one time. The best seed is hand-picked.

Frequently seeds are affected with insects or diseases; this will retard germination or make it impossible. The age of seeds is also important because every seed has a certain period of longevity. In some cases seeds must be sown immediately after ripening, else they do not start. Some seeds, such as those of Cucumbers, are better when two or three years old.

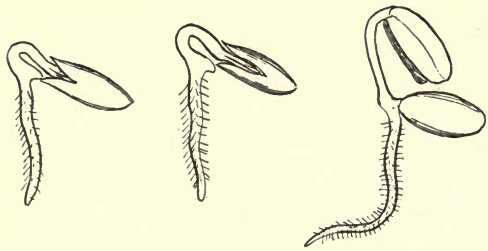

Fig. 2.—Melon germination. Note the knob on the root which catches the seed coat, holding it under the surface of the soil

LONGEVITY OF SEEDS

Regarding the longevity of seeds, H. A. Dreer, Inc., writes:

"It has to be understood that in a favorable season and with perfect harvesting conditions, seeds of all sorts are liable to be of much stronger germination ability than in an unfavorable season, particularly if the conditions at the time of harvesting are not just right. The longevity of many seeds is materially increased because they are now grown in this country, particularly in California, where the conditions for their best development are nearly ideal.

"The life of seeds is no doubt considerably influenced by the conditions under which they are kept over from one year to another. We believe that the proper conditions are a cool, airy place where the bags or receptacles in which the seeds are kept may be spread out, so that the air can circulate around them. This was tested out some years ago by the United States Department of Agriculture, and the result of their investigations seemed to show that seeds kept best under the same conditions that are preferred by most human beings. In other words a temperature of somewhere between sixty and seventy-five degrees is about right."

Commenting on longevity of seeds, Geo. W. Oliver writes: "Instances are common where seeds of various plants have germinated many years after they were gathered. Seeds of several leguminous genera have been known to remain in good condition for a number of years.

"Among these are several which are well authenticated, notably *Desmodium gyrans*, which has been known to remain in good condition for twenty-five years, and *Gymnocladus canadensis*, which has germinated after a long time in storage. Some of the tropical tree legumes have seeds which lose their vitality only after many

years if kept dry and cool. Some seeds are peculiar in that they sometimes develop only the cotyledons and the roots the first season. One or two species of *Ipomœa* have this peculiarity.

"A well known instance of this nature also occurs in one or more of the common Oaks. The seeds of the Coffee plant develop cotyledons which sometimes remain in this condition for several months before true leaves are developed."

Three *Cassia* seeds are known to have germinated when 85 years old. It is doubtful whether the wheat seed found several years ago in the pyramids of Egypt were as old as was claimed, and if so, it is hardly to be believed that they grew.

LONGEVITY, IN YEARS, OF FLOWER SEEDS

(Derived mainly from data furnished by H. A. Dreer, Inc.)

Abutilon.....3-4
Achillea..... 2
Acroclinium.....2-3
Ageratum.....2-3
Agrostemma.....3-4
Agrostis nebulosa.2-3
Alyssum.....2-3
Amarantus 3-4
Ampelopsis..... 1
Anchusa..... 2
Anemone..... 2
Antirrhinum.....3-4
Aquilegia..... 2
Arabis.....2-3
Armeria..... 2
Asters, China....2-3
perennial.....1-2
Auricula..... 2
Balloon Vine.....3-4
Balsam.....6-8
Baptisia.....3-4
Begonia..... 2
Bellis.....2-3
Bocconia..... 1
Brachycome..... 3
Briza maxima....2-3
Browallia.....2-3
Cacalia..... 2
Calceolaria.....2-3
Calendula.....3-4
Calliopsis.....2-3
Campanula.....2-3
Canary Bird Vine.3-4
Candytuft.....2-3
Canna.....3-4
Carnation.....3-4
Cassia.....2-3
Celosia.....4-5
Centaurea..... 2
Cerastium..... 2
Chrysanthemum..3-4
Cineraria.....3-4
Clarkia.....2-3
Clematis paniculata..... 1
Cleome.....2-3
Cobæa.....1-2
Coix.....2-3
Coleus..... 2
Convolvulus.....3-4
Coreopsis..... 2
Cosmos.....2-3
Cyclamen..... 2
Cypress Vine.....3-4
Cyperus..... 1
Dahlia..... 2
Datura.....3-4
Delphinium 2
Dianthus.....3-4
Digitalis..... 2
Dimorphotheca .. 2
Dolichos.....3-4
Dracæna..... 1
Echinocystis.....4-5
Echinops..... 2
Eryngium.....2-3
Erysimum.....3-4
Eschscholtzia.... 2
Eupatorium..... 2
Euphorbia.....3-4
Ferns.....3-4
Gaillardia..... 2
Gaura.....2-3
Geranium..... 3
Geum..... 2
Globe Amaranth.2-3
Gloxinia.....2-3
Godetia.....2-3
Gomphrena.....2-3
Gourds.....5-6
Grevillea..... 1
Gynerium.....2-3
Gypsophila..... 2
Helenium.....3-4
Helianthus.....2-4
Helichrysum.....2-3
Heliopsis.....2-3
Heliotrope..... 1
Hibiscus.....3-4
Hollyhock.....4-5
Humulus..... 1
Hunnemannia.... 2
Iberis.....2-3
Impatiens.....5-6
Ipomœa.....3-4
Iris..... 2
Kochia..... 2
Lantana..... 1
Larkspur—Annual 3-4
Lathyrus latifolius 3-4
Lavandula..... 2
Lavatera.....3-4
Liatris..... 2

LONGEVITY, IN YEARS, OF FLOWER SEEDS—Continued

Linaria cymbalaria 2
Linum.....5-6
Lobelia cardinalis.2-3
Lobelia erinus ...3-4
Lunaria.....3-4
Lupinus.....3-4
Lychnis.....2-3
Lythrum..... 2
Marigold.....3-4
Marvel of Peru..2-3
Matricaria..... 2
Matthiola.....3-4
Maurandia..... 2
Mesembryanthemum 3-4
Mignonette.....2-4
Mimosa.....2-3
Mimulus.....3-4
Momordica.....4-5
Musa.....¼-½
Myosotis..... 2
Nasturtium.....3-4
Nemesia..... 2
Nicotiana.....3-4
Nierembergia.... 3
Nigella..... 2
Pansy.....2-3
Papaver bracteatum.....3-4
Pennisetum.....2-3
Pentstemon..... 2
Petunia.....3-4
Phlox Drummondii 1-2
Physostegia..... 2
Platycodon.....2-3
Poppy.....3-4
Portulaca.....3-4
Primula chinensis. 2
elatior..... 2
Forbesii..... 2
japonica..... ½
kewensis..... 2
malacoides.... 2
obconica..... 1
polyanthus.... 2
vulgaris..... 2
Pueraria.....3-4
Rhodanthe.....2-3
Ricinus..... 3
Rudbeckia..... 2
Salpiglossis.....4-5
Salvia..... 2
Sanvitalia..... 2
Saponaria..... 2
Scabiosa.....2-3
Schizanthus.....2-3
Smilax.....2-3
Solanum.....4-5
Solidago..... 2
Statice.....1-2
Stevia.....2-3
Stocks.....4-5
Stokesia..... 2
Sweet Peas.....3-4
Sweet Rocket....3-4
Tagetes.....3-4
Thunbergia..... 2
Torenia.....2-3
Tritoma..... 1
Tunica.....2-3
Verbena.....2-3
Veronica.....2-3
Vinca.....1-2
Viola.....1-2
Wallflower.....5-6
Xeranthemum... 2
Zinnia.....3-4

LONGEVITY OF VEGETABLE SEEDS

(Revised from Vilmorin)

Angelica.....2-3
Barley..... 3
Beans.....3-8
Beets—garden..6-10
sugar..... 6
Broccoli.....5-10
Buckwheat..... 2
Cabbage.....5-10
Carrot.....4-5
Cauliflower.....5-10
Celery..... 8
Clover, red..... 3
Corn..... 2
Cucumber..... 10
Egg Plant..... 6
Endive..... 10
Flax..... 2
Grass, Millet..... 2
Orchard..... 2
Timothy..... 2
Kohl-Rabi.....5-8
Leek.....3-9
Lettuce.....5-9
Maize.....2-4
Mustard.....4-9
Oats..... 3
Okra..... 5
Onion.....2-7
Parsley.....3-9
Parsnip.....2-4
Pea.....3-8
Pepper.....4-7
Pumpkin.....5-9
Radish.....5-10
Rape..... 5
Rhubarb.....3-8
Rosemary..... 4
Rye..... 2
Sage.....3-7
Salsify.....2-8
Sea Kale.....1-7
Soy Bean..... 2
Spinach.....5-7
Squash.....6-10
Strawberry.....3-6
Thyme.....3-7
Tomato.....4-7
Turnip.....5-10
Watermelon....6-10
Wheat..... 2
Wormwood.....4-6

TESTING SEEDS

A federal law now in force prohibits the importation of adulterated seeds of most of our grasses, besides Alfalfa, Clover and many cereals. Weed seeds as well as seeds of lower commercial value are considered adulterations. The United States Department of Agriculture and State institutions are doing much to enforce the dissemination of good seeds and will test any doubtful samples sent to them. Each grower may test for impurity and adulterations by using a small hand-lens.

Much labor and space is frequently wasted by misjudging the value of seeds. The best test takes into consideration not only the percentage of germination but also the growth during a whole season as well as the amount of impurity.

For the germination test, a soup plate may be conveniently used. (See fig. 3). Circles of canton flannel or blotting paper are cut to fit the plate. By dividing the cloth into four divisions, four varieties of seed may be tested at one time. Either ten or twenty-five of the seeds to be tested are counted and placed upon the cloth which is moistened. The dish is then covered with another plate to prevent drying. Day by day the number of seeds in each division that germinate should be counted. If only 50 per cent germinate the seeds must be sown twice as thickly in planting.

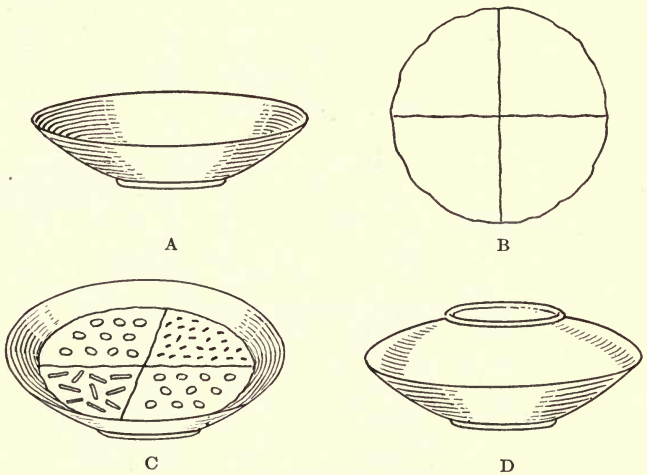

Fig. 3.—Seed testing. A, A soup plate. B, The piece of canton flannel. C, Canton flannel in plate with seeds in each division. D, The plate covered by another one

Before using the cloth for a second test it should be boiled to kill molds which will interfere with the results.

Large seed testers may be purchased, which have space for many kinds of seeds, and in which the temperature and moisture can be perfectly regulated.

Most reliable seedsmen conduct thorough tests of their seeds; not only germination tests but tests of varieties, growing these in test gardens located in various latitudes. Many firms print a statement of the percentage of germination upon each seed package.

TIME TO SOW SEEDS

It is highly important that seeds be sown in season so that the plants will mature at the proper date for their use or sale. Under appropriate headings in the tables given later in this chapter, the time to sow the various seeds is discussed.

SOIL FOR SEED SOWING

Soil for sowing seed must always be finely pulverized and in the best physical condition. A sandy loam suits most seeds the best. Soils which are too heavy should be lightened by the addition of sand or even sifted coal ashes. It always pays to use the best soil for starting the seedlings; if this is not available, in the case of plants that are to grow permanently, the seed may be sown in a good place and the seedlings transplanted later.

Seed beds, if in the proper physical condition, need no manure. The young seedlings are not able to take up much food. In fact, much humus or organic matter may be actually detrimental to the seeds, even hastening disease.

POTS AND FLATS FOR SOWING SEEDS

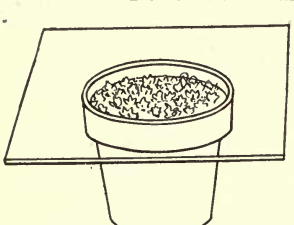

Fig. 4.—Seedlings in pot covered by pane of glass

When a limited quantity of plants are wanted, flower pots (see fig. 4) may be used for seed sowing. Broken pottery and ashes should fill the pot half full and above this should be placed finely sifted soil. Where it is desired to sow a larger quantity of seeds, wooden flats (see fig. 5) will be found more useful. Do not make them much over twelve by eighteen inches, and three to four inches deep. Larger flats are cumbersome and when used for more

than one kind of seed, are hardly ever as serviceable because of the uneven germination. The flats should also contain a layer of some sort of roughage for good drainage.

The soil must be perfectly level and slightly compacted. Make the rows from one inch to two inches apart, according to the seed, and sow the seeds usually from one-quarter inch to an inch apart, according to the variety. Seeds which are sown too thickly are sure to give spindling plants which are difficult to transplant. Sow only seeds requiring like conditions for germination in the same flats. For example: Sweet Alyssum sown in the same flat with Cockscomb is unsuccessful; the Alyssum will be ready for transplanting before the Cockscomb is above the soil.

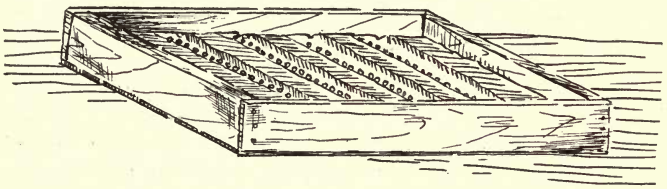

Fig. 5.—Seeds sown in flats (See page 29)

LIGHT AND SEEDS

Most seeds do not prefer light while germinating. In fact, Larkspur, Adonis and Poppies are somewhat deterred in germination by bright conditions. It is usually customary, therefore, to afford some shade to seed beds or pots. Out of doors such shade is supplied by lath screens; indoors, newspapers placed over the pots and seed boxes will be serviceable.

SUGGESTIONS FOR SEED SOWING

Plant in rows. It would seem best to sow most seeds in rows or drills rather than broadcast. (See fig. 5.) By this method they are easily cultivated for the removal of weeds, at the same time transplanting can be more simply done.

Avoid deep planting. Deep planting is a common blunder and a common cause of failure. The supply of oxygen is cut off from the seeds and if the seedlings are small, they encounter difficulties in trying to push up the heavy clod above.

The majority of large seeds should be covered about two or three times their diameter, but in the case of outdoor sown seeds much depends upon the time of the year they are sown.

Firm the soil. In order to bring the moist soil into contact with the seeds, the soil should be firmed over the rows by slight pressure of the hands or feet, or with a hoe. In sowing seeds out of doors late in Summer, this is especially necessary because the soil, to some extent, has lost its moisture.

SOWING VERY FINE SEEDS

An excellent method of getting the best results from very small seeds is to use a mixture of leaf mold and loam and cover with a thin layer of sifted sphagnum moss. The seeds are sown on the sphagnum and are not covered with soil. A pane of glass is placed over the pot. By this method plenty of moisture is available for good germination, but later the watering must be diminished.

Such seeds as those of Petunias, Salpiglossis, Ornamental Tobacco, Begonias, Thyme, Gloxinia, Gesneria, Tydæa, Lobelia, Mimulus and Calceolaria, may be sown in this manner. The water should be supplied from below by placing the pot in a pail of water.

When the sphagnum moss is not used, W. N. Craig* suggests cutting a piece of tissue paper and laying it over the surface of the soil and watering over this. The paper keeps the seeds from washing to the side of the pot and prevents the soil from drying out. The paper decays readily and allows the seedlings to push through it. For young seedlings to become dry for a few hours in the hot sun would be fatal and if too much moisture is available there is danger of decay.

"There is an old-fashioned method of seed sowing specially applicable for seeds which are slow in germinating, such as Primulas and Streptocarpus, though it is also an ideal plan for all fine seeds, including Begonias, and as the writer first saw it in operation many years ago in an old lady's window, he designates it *Grandmother's Method of Seed Sowing.*

"It is simplicity itself, while results are almost certain.

"One and one-half inches of fine soil are placed on top of an ordinary building brick and pressed fairly firm. Sow the seed thinly; very fine seed must only be slightly pressed into the soil, or covered not more than one-sixteenth of an inch. The brick is then placed in a large plate, or flat, containing one inch or so of water,

* Craig, W. N. Seed Sowing Suggestions. From Trans. of Mass. Hort. Society, Part I, 1917, p. 20.

which will keep the brick and soil continually moist, thus eliminating the danger of washing out the seed or of letting the soil become dust dry, as so often happens when using pots or boxes.

"It is well, however, to guard against overwatering; therefore, if the soil at times appears to be too wet, remove the brick from the water for a few hours until it partly dries out."*

WATERING

Great care should be exercised in watering, not only because the seed may be washed out of the drills, but excess water may cause the spread of the damping-off fungus. This disease is especially bad when the seedlings lack air. Small dribblings applied frequently, rather than proper applications of water at needed intervals, cause the formation of a crust which will interfere with the ease of germination; later they cause an unbalanced and shallow root system.

TIME REQUIRED FOR GERMINATION

Seeds vary greatly as to the number of days they require for germinating. Many gardeners make a grave blunder by discarding a seed bed before an opportunity has been given the seed to come up under normal conditions. As new seeds will often germinate more rapidly than older ones, when old and new seeds are mixed the seedlings may continue to appear for weeks.

GERMINATION TABLE IN DAYS

	Days		Days		Days
Abutilon	20	Balloon Vine	25	Canary-bird Flower	†
Acroclinium	15	Balsams	10	Candytuft	5
African Golden Daisy	15	Begonias	15	Cannas	†15
Agapanthus	20	Bellis perennis	5	Canterbury Bells	†15
Agathæa cœlestis	20	Blanket Flower	20	Cardinal Climber	5
Ageratum	5	Blue-eyed Daisy	20	Carnations	8
Alyssum	5	Blue Day Flower	20	Carnations, Perennial	8
Ampelopsis	15	Blue Salvia	†15	Castor Beans	15
Anchusa	20	Boston Ivy	15	Celosia	20
Anemone, St. Brigid	15	Brachycome	8	Centaurea	†5
Antirrhinum	20	Brazilian Morning Glory	8	Centrosema	15
Aquilegia	15	Browallia	20	Chinese Bellflower	30
Arctotis grandis	20	Brugmansia arborea	15	Christmas Orchid Flower	20
Asparagus	30	Bush Eschscholtzia	8	Chrysanthemums	5
Asters	8	Butterfly Pea	15	Cigar Plant	†8
Asters, Perennial	15	Cactus	30	Cineraria	5
Baby's Breath	20	Calendula	10	Clematis, Tuberous	†30
Ball of Fire	15	California Poppy	8		
Bachelor's Button	†5	Campanula	8		

* From Suggestions for Seed Sowing. Published by W. Atlee Burpee & Co.

† Indicates an indefinite number of days.

GERMINATION TABLE—Continued

	Days
Cleome pungens	20
Cobæa scandens	15
Cockscomb	20
Coix lachryma	*
Coleus	20
Columbine	15
Commelina	10
Coreopsis	20
Cornflower Aster	*
Cosmos	5
Crimson Flax	8
Cuphea	*8
Cyclamen	25
Cyperus alternifolius	25
Cypress Vine	5
Dahlias	5
Daisies	20
Daturas	15
Delphinium	15
Dianthus	5
Digitalis	20
Dimorphotheca	15
Dolichos	15
Dusty Miller	*5
Echinocystis	*30
English Double Daisy	5
Eschscholtzia	5
Euphorbia	20
Evening Primrose	5
Everlasting Flowers	*
Feverfew	20
Fire-Cracker Plant	*8
Fire-on-the-Mountain	20
Forgetmenot	15
Four o'Clock	5
Foxglove	20
Fuchsia	*30
Gaillardia	20
Geraniums	20
Gloxinia	15
Godetia	15
Gourds	15
Grass Seed	*
Gypsophila	20
Helianthus	15
Helichrysum	5
Heliotrope	15
Heuchera sanguinea	20
Hibiscus	*15
Hollyhocks	5
Hop, Japanese	15
Horn of Plenty	15
Humble Plant	8
Hunnemannia	8
Hyacinth Bean, Japanese	15
Ice Plant	*5
Impatiens Sultani	15
Ipomœas	5
Iris	*50
Ivies	*
Jack-and-the-Beanstalk	15
Japanese Bean	15
Japanese Hop	15
Japan Iris	*50
Jerusalem Cherry	*20
Job's Tears	*
Kenilworth Ivy	5
Kochia scoparia	15
Kudzu Vine	15
Lantana	15
Larkspur	15
Lathyrus	25
Lavender	20
Lemon Verbena	8
Linaria	5
Linum	8
Lobelias	8
Love-in-a-Mist	8
Lychnis	20
Mallow Marvels	*15
Marigold	5
Marvel of Peru	5
Maurandia	*25
Mexican Fire Plant	20
Mesembryanthemum	*5
Mignonette	5
Mimosa	8
Mimulus	8
Mina lobata	5
Mirabilis	5
Monkey Flower	20
Moonvines	20
Morning Glory	5
Mountain Honeysuckle	20
Mourning Bride	20
Musk Plant	20
Nasturtium, Dwarf Tall	8
Nicotiana	20
Nigella	8
Œnothera	5
Ornamental Grasses	*
Ostrich Plume	20
Oxalis	20
Palm	15
Painted Tongue	5
Pansies	8
Passion Flower	50
Peas, Sweet	15
Pelargoniums	20
Pentstemon	20
Perennial Peas	25
Petunias	20
Pheasant-Eye Pink	5
Phlox	20
Pinks	5
Platycodon	*30
Poppies	20
Portulaca	20
Primroses	*15
Primulas	*15
Pueraria Thunbergiana	15
Ragged Robin	20
Ricinus	15
Rose	*
Rose, Moss	20
Salpiglossis	5
Salvia	*15
Scabiosa	20
Scarlet Runner	8
Scarlet Sage	*15
Schizanthus	20
Sensitive Plant	20
Shasta Daisy	20
Smilax	15
Snapdragon	20
Solanum	*20
Spider Plant	20
Stocks	5
Stokesia	*
Straw Flower	5
Summer Bush Cypress	15
Sunflower	15
Sun Plant	20
Swan River Daisy	8
Sweet Peas	15
Sweet Sultan	*5
Sweet William	10
Ten-Weeks Stocks	5
Umbrella Plant	25
Verbena	8
Vinca	*
Violas	*
Violets	*
Wallflower	5
Water Lilies	*
Wedding Bells	15
Wild Cucumber Vine	*30
Youth and Old Age	5
Yucca	*
Zinnias	5

From the Catalog of Conard & Jones Co., West Grove, Pa.

* Indicates an indefinite number of days.

QUALITY OF BLOOM AS RELATED TO RATE OF GERMINATION

Many of the first seedlings of florists' flowers are the strongest yet the poorest in floral quality. The gardener is careful to save the later and more puny seedlings, for they often produce doubles and the finer or newer colors. This is especially true of Petunias and Primroses. T. D. Hatfield* writes: "Among Rhododendrons the first in a batch to bloom are always the strongest growers and the poorest in flower."

SIZE OF SEEDS AS RELATED TO VALUE

Prof. M. B. Cummings of the Vermont Agricultural Experiment Station, reports in Bulletin 177 the results of experiments with large heavy seeds *vs.* small or light seed and tells us that with Sweet Peas the larger seeds gave more vigorous plants, of greater height and more foliage. The seeds germinate better, the plants produce more blooms and the blossoms appear earlier. In the same way large seed was more favorable in the case of Hubbard Squash, Sweet Pumpkins, Lettuce, Parsley, Radishes, and Beans. Mr. Cummings says, "The discard of small seed and the use only of the large and the medium sizes entails some loss of seed, which would amount to but little, except with high priced seed, but which would effect a considerable saving in the matter of production. Moreover, the price of seed is one of the smaller items in the cost of producing a crop. It is better to waste at the beginning of a season than at the end, to waste seed rather than the time and labor expended in growing a crop. It costs little more to nurture a good crop than a poor one. Why not insure the crop so far as seed selection can accomplish that end?

"In market gardening operations, lateness of maturity and lack of uniformity may destroy profits or even turn profit into loss. A multiplicity of plants too small or too poor to market may be due to the use of small seed interspersed with larger seed."

SPECIAL TREATMENTS TO HASTEN GERMINATION

Certain seeds germinate very slowly when handled by ordinary methods. In these cases time can be saved and better results secured by employing special practices such as the following:

1. *Covering seed with burlap.* In sowing seeds of Parsley, Celery, New Zealand Spinach, Pansy, Bellis and all perennials (in

* Hatfield, T. D. Methods Used in Propagation of Plants. From Trans. of Mass. Hort. Soc., 1916, p. 100.

Summer), the rows should be covered with burlap which will conserve the moisture and hasten germination.

2. *Soaking seeds.* Garden seeds, especially Beans, Peas, Beets, Squash, Cucumbers, Celery, Parsley, and Parsnips, may be soaked in water. Such soaking should be continued only until the seed coats are softened; further soaking injures the seeds, causing them to decay when sown in the moist soil. Proper soaking hastens germination and is beneficial, but it is better not to soak them at all than to allow them to remain in water too long.

In some experiments carried out in France, and described in *Le Jardin*, seeds of Radishes and other cruciferæ were made to germinate in less than eight minutes by plunging them in hot water and then laying them between rags soaked in boiling water in a small flower pot nearly filled with moist earth, and keeping them at a warm temperature.

3. *Filing seeds.* As an example of a very hard seed we may take the Canna, a seed which is as hard as shot. F. P. Avery describes an experience with starting seed. He says: "March 22d I received some seed. I have access to an emery wheel, and I ground down to the white meat on every seed. That same evening I poured hot water on them, and kept them in hot water until the evening of March 27th, giving the seeds a five-day bath. I then found four seeds showing a white germ the size of a pinhead. I put the lot in a big dish of sand, covering them about an inch. The dish stood in a hot place over a stove, where the seeds luxuriated in bottom heat and had hot sunshine. Fifteen days after I put the seeds to soak there were more than two hundred plants, averaging two inches in height." Instead of using an emery wheel, the seeds are frequently nicked with a file. *Ipomœa* and *Musa ensete* seed need to be filed in this way.

4. *Stratifying seeds.* Certain hard seeds, including many nuts, are often "stratified" in flats over Winter. A layer of sand is placed in the flat, then a layer of seeds, then more sand and so on until the flat is full. The flat is then placed where the soil will alternately freeze and thaw, this action tending to crack the coats of the seeds. In the Spring the seeds are dug or sifted out of the sand and sown in the usual way. (See shrub and tree seeds, pps. 41-44.)

5. *Scalding seeds.* Seeds which are not affected by freezing are frequently scalded. Boiling water is poured over them and allowed to cool. This process is used with seed of the Honey Locust, the Kentucky Coffee Tree, Acacia and Chorizema.

6. *Treating with acids or alkalis.* Seeds with a hard, bony covering are frequently treated with weak acids which serve to soften the seed coat. If Raspberry or Blackberry seeds are soaked in vinegar their germination will be hastened.

Sweet Peas are treated with sulphuric acid, commercial strength, for half an hour, then thoroughly washed. Old seeds or those with a very hard, dark coat will frequently germinate after this treatment when they would not otherwise. With the increased growing of Sweet Peas which produce but few seeds, such as the Winter Flowering Spencers, it has become highly desirable that each of the expensive seeds germinate. White and mottled seeds do not usually need acid treatment. It is suggested that should seed fail to germinate without treatment it be sifted from the soil and steeped in acid.

Many of the leguminous farm seeds fail to germinate because, as the farmers say, they contain "hard seed." In dry seasons, especially, there frequently results a very poor germination. Experiments have shown that Clover, Cotton, Alfalfa and some other seeds benefit from such a soaking as advised above for Sweet Peas.

In the *Agricultural News* of Barbadoes, West Indies, we read: "If seeds are treated with chlorine water (two drops of chlorine to 60 c.c. of water) and then stood in the sun, they will germinate completely in six hours. The seeds must be removed from the chlorine water, and washed, however, directly the radicle appears. Chlorine has a decomposing effect on water in the presence of light, breaking it up into hydrogen and oxygen, and the rapid germination is due to the action of the nascent oxygen liberated by the chlorine. Hard seeds need a preliminary soaking in water before steeping them in chlorine solution. Alkaline substances, e. g., ammonia, soda, etc., in highly dilute solution, also aid the process of germination.

"Another curious method consists in watering the seeds with a solution of formic acid (1 in 5000) at a temperature of 25° to 30° C. This treatment dissolves the integument, and plants which normally require eight or ten days will germinate in as many hours."

SOWING SEEDS OF PERENNIAL FLOWERS

In sowing the seeds of perennial flowers, coldframes are used. The seeds are sown in rows about six inches apart. After sowing, the frames should be watered and the soil mulched with cut grass or a layer of finely sifted, well decayed, manure. This mulch will serve to keep the soil from drying out and prevent the formation of a crust over the seeds. If the manure is used it will supply the seedlings with food.

Many perennials bloom the first year from seed; these may be sown in early Spring. The other sorts, of which plants are wanted for the succeeding year but which are not expected to bloom during the current season, are sown in July or August. The late sown perennials will be just germinating during the hot, dry season; moisture must be supplied and some kind of screen (see figs. 7 and 8) used to shade the bed, especially, when the seedlings are very small.

The seedlings when transplanted may be placed in 2-inch or 2½-inch pots or they may be planted in frames. (See fig. 6.) If the rows are planted 5 inches apart ample room for their growth is available by removing, from alternate rows, the plants for Fall or early Spring sale. Some of the perennials remaining in the frames may be left to bloom, as the rows will then be 10 inches apart.

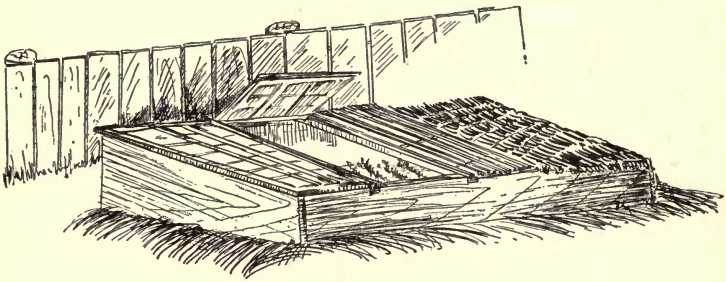

Fig. 6.—Coldframe for sowing perennials. The first and second sections are provided with sashes, the third has a lath screen for shade and the fourth is covered with a straw mat for Winter protection

AQUATICS FROM SEED

Certain seeds of aquatic plants when not kept in water must be artificially treated by acid or nicking. Sow each seed in a separate thumb pot, submerging the pots in tanks of warm water. Many of the sorts, if started in February, flower the first year. Seeds of the following water plants should be treated as suggested: *Acorus* (Sweet Flag), *Aponogeton* (includes *Ouvirandra*, the Lace Leaf), *Cabomba* (Parrot's Feather), *Caltha* (Marsh Marigold), *Cyperus* (Sedges and Umbrella Palm Grass), *Eichhornia* (Water Hyacinth), *Limnanthemum* (Floating Heart), *Limnocharis* (Water Poppy), *Ludwigia*, *Nelumbium* (Egyptian Lotus), *Nymphæa* (Pond Lily), *Orontium* (Golden Club), *Pontederia* (Pickerel Weed), *Sagittaria* (Arrowhead), *Typha* (Cattail) and *Zizania* (Water Oats).

Many of these seeds may be sown in larger pots as other perennials but they should be submerged.

Geo. W. Oliver writes: "Seeds of the Gigantic Water Lily, *Victoria regia*, should be sown in February in the warmest house. The water must be clean and free from the lower forms of aquatic growth. The seeds should be sown in thumb pots, one to a pot. The first leaves of the seedling Victoria are grass-like, then halberd-shaped, but eventually assume the peltate form. In Washington when properly grown the leaves of the seedling should be 12 inches in diameter by the 10th of May.

"Many attempts to grow this, the queen of Water Lilies, are frustrated because the young plants are taken from a warm temperature and placed in water out of doors, the temperature of which is much below that of the hothouse. To grow the Victoria successfully the receptacle for the plant should be large enough to hold at least several cartloads of rich soil and a good sized frame and sash on top of the soil. The water in a frame so arranged will be kept warm and the young plants will develop rapidly by this treatment. When the plant has made a start the frame and sash are removed.

"Subsequent attempts to grow this queen of aquatics without the protecting frame always resulted in poorly developed plants. When a good flower of the Victoria opens about mid-Summer or later save some of the pollen from it and dust it over the stigmas of the succeeding flowers. This will result in the ripening of many seeds.

"The size of this plant, the first one grown in Washington, was much larger than any other plant grown out of doors in this country, the diameter being 6 ft. 6 inches. During the following Summer the frame was discarded and the result was a much smaller Victoria."

CACTUS FROM SEEDS

Most Cactus seed is very fertile but relatively few growers know how to supply the best conditions for germination and growth. Chas. H. Thompson* has determined the proper method.

The best soil consists of equal parts of a well decayed sod and pure sand. The soil should not be rich in humus because this is a medium for germs of decay. Four-inch pots are used. They should either be new or else carefully burned or sterilized, otherwise Algæ will choke out the young seedlings. The drain hole at the bottom of the pot should be enlarged and the pot filled one-fourth full of finely broken pots, on which the soil is carefully placed and pressed lightly.

The seeds are sown and covered with a very thin layer of soil upon which is spread a one-fourth inch layer of gravel. The gravel

* Thompson, Chas. H. Ornamental Cacti; Their Culture and Decorative Value. U. S. Dept. of Agr. Bur. of Plant Industry, Bulletin 262.

serves to keep the soil from washing, facilitates the passage of moist air and by shading prevents the surface soil from drying. When the seedlings grow they force their way through the gravel and for some time appear small and globular. They are tender, juicy and readily damp-off. The temperature should be about 70 degrees. Transplant into flats of similar soil when several spines have formed on the plants.

FLORISTS' SEED TIME TABLE

Abutilon. Flowering Maple. Sow seed in Spring; blooms in Fall.

Acacia. *A. Baileyana, A. cyanophylla* and *A. podalyriæfolia* are good from seed. To soften seed coat pour boiling water over them and let stand eight to ten hours; 55-60 degrees. Germinate two to six weeks. Use sand, leaf mold and loam.

Acanophœnix. Many seeds remain two years before germination; 70 degrees. (See other palms, p. 158.)

Alocasia. Use peaty soil; 75 degrees.

Annuals. Half hardy. Sow in flats or pots in March. Hardy. Sow in April or later out of doors. (See list on page 176.)

Ardisia. (See page 144.)

Areca. (See page 160.)

Asparagus. Sow in February or when seed is ripe, in flats; 70 degrees. Shade till germinated.

Begonia. *B. semperflorens.* Sow thinly in January or February in flats or pots. Use leaf mold and soil. Bottom heat 75-80 degrees; ten days to germinate. Thick sowing causes damping-off.

Tuberous. Sow in January or February. Use one part leaf mold, one sand, one loam. Germinate in three weeks; 70 degrees.

Bellis or **English Daisy.** Sow in August in coldframe; in January in greenhouse. Shade until seedlings are well up.

Buddleia. February. Cuttings preferred.

Calceolaria. January, February or June. (See page 31.)

Camellia. Soak seeds in warm water. Sow in sandy peat soil. Germinate in four to six weeks.

Carludovica. (See culture for Kentia, page 158.)

Cineraria. Sow in May for Christmas; August 15 for Easter; September 15 for succession.

Cocos. (See page 160.)

Cyclamen. July to January in flats; fifteen months to bloom from seed. Use leaf mold and light soil. Germinate three to four weeks; 55-60 degrees.

Dracæna. *D. indivisa.* February. Sandy soil; 65 degrees.

Dusty Miller. January to March. Light soil.

English Daisy. (See Bellis.)

Gesneria. January. (See page 31.)

Gloxinia. January to February. Flats. (See page 31.)

Grevillea. (Silk Oak.) December to March. Flats; 50 degrees.

Jerusalem Cherry. January to March according to size of plant wanted. Flats; 60 degrees.

Kentia. (See page 158.)

FLORISTS' SEED TIME TABLE—Continued

Myosotis. (Forget-me-not.) August 15 in coldframe; January in greenhouse.
Palm. (See page 158.)
Pansy. August 10. Coldframe. Give loose mulch after freezing.
Pentstemon. For bedding, sow in January.
Perennials. Sow May to August in flats or coldframe. (See pages 36 and 174.)
Primrose. *P. obconica.* Early crop in March. Second in May. If delayed until Summer, seeds do not germinate so well.
P. chinensis. April.
P. kewensis. February.
P. Malacoides. June for early; August and September for Easter. If sown too early the plants get too thick and decay in hot weather.
Smilax. February to April. Flats; 50 degrees.
Solanum. (Ornamental Peppers.) February to May according to size of plant wanted. Flats; 60 degrees.
Sweet Peas. According to Dr. A. C. Beal who has given much study to the Winter flowering sorts. Seed sown:
August 20, blooms Christmas.
September 1, blooms January.
September 15 (main crop), blooms February.
October, blooms March.
November, blooms late March.
December, blooms April.
January, blooms April to May.
February, blooms from May on.
March, blooms May and June.

George J. Ball in *The Florists' Review*, June 6, 1918, gives the following succession sowing data:

1. Mid-August. First crop flowers in October. Profitable crop during seasons that are not too dark. Sometimes crop is entirely lost. Good for Christmas and St. Valentine's Day but not for Easter. Requires 10 ft to 15 ft. of headroom.

2. Main crop to follow Chrysanthemums. Plant rows from 2-inch pots. Require 10 feet headroom at most, often only 6 ft. to 8 ft. Good for Easter and Memorial Day.

3. Spring crop. Grown from late Winter planting (January or February.) Usually this crop does not show as strong growth nor as good stemmed flowers. Side benches may be used, giving headroom of 4 ft. to 5 ft. Occupies space cleared about St. Valentine's Day.

For treatment of seed see page 36.

One pound of seed is sufficient for 400 feet for drilling or for 800 feet if set 2 inches apart. Set early plants 2 to 3 inches apart; later ones 2 inches apart. Good seed is too expensive to sow thickly and thin later. Sow seed ordinarily two weeks before plants are wanted to set in the beds; in coldest weather, 4 to 6 weeks. Space rows 1 to 5 feet apart according to date of sowing.

Verbena. February. Flats.
Vinca. *V. rosea.* Sow late in August in frames; sow December and during Winter indoors in flats or 2-inch pots.
Viola or **Bedding Violets.** August, in coldframe.

TIME TABLE FOR VEGETABLE SEED SOWING*

Earliest safe dates for planting vegetable seeds in the open in the zones of the United States illustrated in figure 6A.

Crop	No. of days for Maturity	Zone D	Zone E	Zone F	Zone G
Asparagus	.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1...	May 1 to 15.....	May 1 to June 1..
Artichoke					
Globe	.....	Apr. 15 to May 15..	May 1 to 30.....	(Not grown).....	(Not grown).....
Jerusalem	.....	Mar. 15 to Apr. 1..	Apr. 1 to 15.....	"	"
Beans.					
Snap	40–65	Apr. 1 to May 1...	May 1 to 15.....	May 15 to June 1..	May 15 to June 15.
Lima	70–100	May 1 to 15.....	May 15 to June 1...	May 15 to June 15.	.....
Beets	60–80	Mar. 15 to Apr. 15..	Apr. 15 to May 1...	May 1 to 15.....	May 15 to June 1..
Broccoli	.....	"	"	"	"
Brussels Sprouts	.....	"	"	"	"
Cabbage	80–130	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to May 15.
Carrots	70–100	Mar. 15 to Apr. 15.	Apr. 15 to May 1...	May 1 to 15.....	May 1 to June 1..
Cauliflower	100–130	"	"	"	"
Celery	120–150	"	"	"	"
Chard	.....	"	"	"	"
Collards	100–120	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	.....	.....
Corn, Sweet	60–100	Apr. 1 to May 1...	Apr. 15 to May 15..	May 1 to June 1..	May 15 to June 15.
Cucumbers	60–80	Apr. 15 to May 1..	May 1 to June 1...	May 15 to June 15.	June 1 to 15.....
Egg Plant	100–140	"	"	"	(Season too short.)
Garlic	.....	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to 15.....
Kale	90–120	"	"	"	"
Kohl-Rabi	.....	Mar. 15 to Apr. 1...	Apr. 1 to May 1...	May 1 to 15.....	May 15 to June 1..
Lettuce:					
Head	.....	Mar. 15 to Apr. 15..	"	"	"
Loaf	60–90	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to 15.....
Melons	100–150	Apr. 15 to May 1...	May 1 to June 1...	June 1 to 15.....	.....
Mustard	.....	Mar. 15 to Apr. 1...	Apr. 1 to May 1...	May 1 to 15.....	May 15 to June 1..
Okra, or Gumbo	90–140	Apr. 15 to May 1...	May 1 to 15.....	May 15 to June 1..	June 1 to 15.....
Onion:					
Sets	60–120	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to 15.....
Seeds	130–150	Mar. 15 to Apr. 1...	Apr. 1 to May 1...	May 1 to 15.....	May 15 to June 1..
Parsley	90–120	"	"	"	"
Parsnip	125–160	"	"	"	"
Peas:					
Smooth	40–80	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to June 1..
Wrinkled	.....	Mar. 15 to Apr. 1...	Apr. 1 to May 1...	May 1 to 15.....	May 15 to June 1..
Peppers	100–140	Apr. 15 to May 1...	May 1 to June 1...	June 1 to 15.....	.....
Potatoes:					
Irish	80–140	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to June 1..
Sweet	140–160	Apr. 15 to May 1...	May 1 to June 15..	June 1 to 15.....	.....
Pumpkins	.....	"	"	"	.....
Radish	20–140	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to 15.....
Rhubarb	.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1...	May 1 to 15.....	May 15 to June 1..
Salsify	120–180	"	"	"	"
Spinach	30–60	"	"	"	"
Squash	60–160	Apr. 15 to May 1...	May 1 to June 1...	June 1 to 15.....	.....
Tomatoes	80–125	Apr. 15 to May 1...	May 1 to June 1..	May 15 to June 15.	June 1 to 15.....
Turnips	60–80	Mar. 1 to 15.....	Mar. 15 to Apr. 15..	Apr. 15 to May 1..	May 1 to 15.....

HANDLING SHRUB AND TREE SEEDS

When the fruits of many of the berried or juicy fruited shrubs are thoroughly ripened, they should be gathered and placed where they will ferment. This will allow the pulp to be washed from the

*Table from "The Farm Garden in the North," by Jas. H. Beattie, being Farmer's Bulletin 937 of the U. S. D. A.

SOWING VEGETABLE SEEDS FOR GREENHOUSE CULTURE

	Northern Ohio*	Virginia†	Southern States‡	
			First Planting	Second Planting
Cucumbers....	Fall crop, July 15, matures Oct. Spring crop, Feb. 1, matures Mar. 15 to Aug. 1	Sow Sept. 1-15 Mature December	March 15 to Apr. 15	July 1
Lettuce.....	First, Aug. 10 continuous to Mar. 15; cut Oct. 15 to June 1	Sow Sept. 20-30. Mature December	Feb. 15 to Apr. 1	August to Nov
Radishes.....	Sept. 1 continuous to Mar. 1. Pull from Nov. 1 to May 1	Sow Feb. 1-15 Mature 4-6 weeks	Feb. 1 to May 15	August to Nov. 1
Tomatoes....	Fall crop June 15, mature Oct. Spring crop Jan. 15, mature Mar. 1	Sow Sept. 15 to Jan. 1 Mature Nov., Jan., June	In beds Feb. 15 to Apr.	June 1 to July

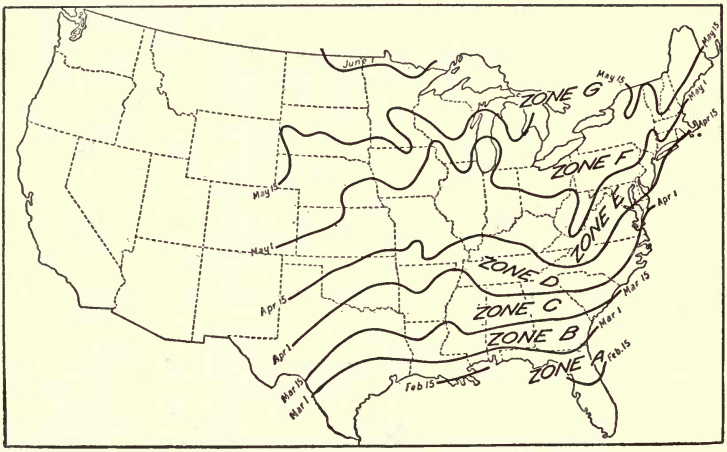

Fig. 6A.—A zone map of the United States, based on the average dates of the latest killing frost in Spring. From Farmer's Bulletin 937.

seeds. After being washed out of the pulp and dried, the seeds are often stratified or sown immediately in flats, placed in coldframes and subjected to the Winter freezings which will soften and crack their seed coats. Some growers prefer to wait until February before subjecting the seeds to the frost.

Sand is frequently used instead of soil as the material in which to sow the seeds. When the ground can be worked in the Spring the seeds are sifted from the sand and sown in rows. If planting

*Dates obtained from H. J. Ruetenik, Cleveland, O.
†Dates obtained from A. G. Smith, Jr., Blacksburg. Va.
‡Dates obtained from "Gardener's and Florists' Annual," 1918.

is delayed the seeds will have sprouted and will suffer injury when handled.

Some of the shrubs, of which the seeds require stratification are:

Berberis	Dirca	Ligustrum	Styrax
Boston Ivy	Euonymus	Lonicera	Symphoricarpos
Cotoneaster	Halesia	Rhamnus	Viburnum
Cratægus	Hamamelis	Rhodotypos	
Cydonia	Ilex	Roses	

A few of the trees requiring this treatment are

Acer	Catalpa	Hicoria	Sassafras
Ailanthus	Fagus	Juglans	Tilia
Betula	Fraxinus	Liriodendron	
Castanea	Ginkgo	Robinia	

The *Gardener's Chronicle* (Gr. Britain), gives the following interesting statistics showing the number of plants that may be grown from a bushel of seed: "Horse Chestnut, 2500; Oak, 6000; Spanish Chestnut, about 3000; Walnut, 5000; Norway Maple, 12,000; Sycamore, about 12,000; Ash, 14,000; Beech, 10,000; Elm, 1000; Birch, fully 16,000; Holly, 17,000; Scotch Fir, 9000. From one pound of seed: Spruce Fir, about 9000; Larch, 3000; the Cluster Pine, Silver Fir and some others, about 500 upward."

Jenkins in the "Art of Propagation" gives excellent notes on the practice of raising trees from seed. He writes: "As a general rule forest tree, and many other seeds, should be planted in the Fall soon after they ripen, or, if reserved for Spring planting, should be mixed with earth, moss, leaves, or other material, to prevent drying; imitating, in a measure, the conditions and protection provided in nature.

For seeds of the nut-bearing tree class such as the Oak, Chestnut, Hickory, black and white Walnut, the open field, if of mellow, rich soil, makes a good and sufficient seed bed.

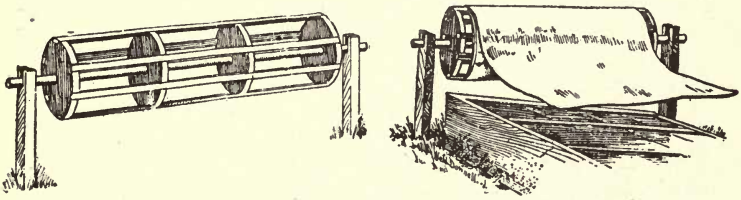

Fig. 7.—An excellent method of having a screen which can be rolled over the seedlings in a coldframe

After the ground is thoroughly cultivated, mark out with a plow as for Corn or Potatoes, planting the seeds closely in the light furrows or drills.

The drills may be any convenient distance. If to be cultivated with a hoe they need be but a foot apart; but, unless cramped for room, they had better be made three or four feet apart, so that the space between them may be stirred with the horse hoe or cultivator.

If the planting is done in the Fall, it is better to mulch the ground with straw, leaves, marsh hay, or any like material; this will prevent baking of the soil after the Spring rains, and keep it in a nice mellow condition. The mulching should be removed in the Spring, or at least enough so that it will not interfere with the growth of the young seedlings.

The smaller seeds, such as those of Maple, White Ash, Tulip, Linden, Magnolia, etc., require greater care in planting.

Let the soil be thoroughly pulverized, then throw it up into beds a few feet wide and any desirable length. Mark out and plant in drills by placing a board across the bed, making the drill along the edge of the board with a sharpened stick, of with the corner of the hoe; then sow the seed in the drill as you would Peas or Beet seed; cover lightly, then turn forward the board for a new drill. The width of the board regulates the distance apart of the drills, and as such seedlings are not usually allowed to grow more than one year before transplanting, the board need not be more than eight or ten inches wide. Mulch with straw if planted in the Fall, removing the same in the Spring.

Gathering Tree Seeds. Seeds of the nut-bearing trees are generally easily gathered, but with Maple and other small seeds, gathering from the ground is exceedingly tiresome. Many of the small seeds, when fully ripe, may be shaken from the tree onto large sheets of canvas spread underneath.

With Maples, if the tree can be spared it may be cut down when the seed is nearly ripe and first begins to fall. The seed can then be rapidly stripped from the branches by hand. On small trees they may often be gathered from the branches without cutting the tree. In gathering, after they have fallen on the ground, the leaves must first be raked off, and the seed gathered up mainly by hand picking.

Tulip tree seed is gathered when the cones first begin to open. The cones, which are made up of seeds, are usually picked from the tree by an active climber. Seed of our northern *Magnolia acuminata* develops in pods, closely resembling young Cucumbers, hence the name, Cucumber Tree. These pods may be gathered after they have turned a red or pink color, and begin to open showing the red seeds. Spread them out in the air after they are gathered. In a few days the seed is readily shelled out."

CONIFERS FROM SEED

Until the Quarantine 37 was enacted, few American nurserymen grew evergreen seedlings. Conditions in Holland and Belgium have always been considered more congenial to the propagation of evergreens, but now excellent stock is being produced in America.

The following conifers are grown from seed either for sale or to be used as stock upon which to graft the choicer varieties:

Abies (see page 180).
Biota (Oriental Thuya, see page 217).
Cedrus (see page 188).
Chamæcyparis (see page 190).
Cryptomeria (see page 192).
Juniperus (see page 198).
Larix (see page 200).
Libocedrus (see page 200).
Picea (see page 206).
Pinus (see page 207).
Pseudolarix (see page 208).
Pseudotsuga (see page 208).
Retinispora (see page 210).
Sciadopitys (see page 215).
Taxodium (see page 217).
Taxus (see page)217.
Thuya (see page 217).

Excellent notes on the propagation of conifers from seed were contributed to THE FLORISTS' EXCHANGE of Aug. 9 and 16, 1919, by A. H. Hill. These articles follow:

In the growing of conifer seedlings, generally speaking, the first point of importance in mapping out plans for production on a commercial scale is to locate a reliable and unfailing source of seed. It is easy enough to talk about producing a million little conifer seedlings, but in order to make this possible there must be seed of good quality and quantity. At first thought, it would seem easy to secure the necessary seed when one thinks of the native evergreen forests with their countrywide range. However, the problem is different from that which confronts the farmer when he wants Wheat or other agricultural seeds for the growing of his annual crops. Fortunately the procuring of tree seeds is now rendered less difficult because there are a number of excellent firms in America which specialize in tree seeds.

It is a source of great satisfaction to know that the Department of Agriculture in Washington has a seed testing laboratory in which germination and purity tests are made and the number of seeds per pound determined of all species collected. In addition to germination tests, the seed testing laboratory is conducting experiments to determine the relative merits of a number of methods of storing conifer seeds.

Too much importance cannot be placed on the necessity of obtaining the best and hardiest types, and this requires constant research, travel and experiments. While on the subject of seed supply, permit me to explain briefly some of the interesting points concerned

therewith. For the grower who is desirous of continually improving the type and controlling the source of his supply of seed, the first thing is to build up a list of local seed collectors in various parts of the country, and then educate them to get what you want. It is not an easy task, I assure you. The ordinary woodsman is not acquainted with the various varieties, and the differences between the Fir and the Spruce mean but little to him. It requires a great deal of patience. You must be willing to pay for his mistakes; sometimes he collects the cones too early and the seed is worthless; another time he waits until the seed has fallen from the cones and the operation is a failure.

We have had collectors ship several hundred pounds of Juniperus berries, and not one berry in the entire consignment contained a live germ. It requires two years for the berries of some of the Juniper varieties to develop into maturity. The ripe, matured berries are a deep purple in color, and usually located back among the foliage near the center of the tree, while the green, immature berries are out on the tips of the branches, and are the ones that the collector will naturally gather. It is a good plan to keep in touch with your collector throughout the entire year. Write to him often; ask him to send samples of the young cones, even though the samples are worthless and of no value; it helps to keep his interest up.

COLLECTING THE CONES

It is found that there are three methods of collecting cones: from felled trees, from standing trees and from the squirrel hoards. Where logging is going on, it is often possible to pick cones from the felled trees on the ground after the brush is piled. In collecting from standing trees it may or may not be necessary to climb. Cones can often be stripped from short limbed trees by cone hooks fastened to poles, or even picked off by hand. Squirrels' caches are often excellent places from which to get cones; Pine squirrels collect and store large quantities. The squirrels do not put by seed for Winter only, but continue to collect as long as the supply lasts and the weather permits. It is not uncommon to find in a single one of their caches from eight bushels to twelve bushels of good cones. These caches are located in hollow logs, springy places, and muck, as well as under bushes and felled tree tops. The squirrels do not confine their collecting to a few species, but appear to relish a large variety. Among the species of cones which are often obtained from the squirrels' hoard, are Douglas Fir, Engelmann Spruce, Blue

Spruce, Ponderosa Pine, and White Pine. Usually, however, the cones of but one species are found in a single cache.

Take White Pine as an example. It grows naturally over the New England states. It is also scattered generally over Michigan, Wisconsin, Minneosta, and portions of Canada. In certain years the White Pine in Canada will bear a good crop of cones while the cone crop elsewhere is a failure; it is therefore necessary to have a number of collectors in all sections where the desired conifers are growing. The conifers of the Rocky Mountains grow rather generally all over the range from New Mexico north, and the Pacific Coast produces trees well over the entire western slope.

Seeds are collected in quantity during the seeding years which only occur two, three or more years apart. In most varieties of conifers it is therefore necessary to secure seed during the seeding year, to store until fresh seed is again available. Many of the varieties lose their germinating power rapidly after they have been taken from the cones. However, this difficulty is overcome in various ways. Take, for instance, the Douglas Fir, from Colorado; if seed has been stored over for two years it will be necessary to plant double the quantity of seed to give the necessary amount of seedlings per square foot. Sometimes the collectors extract the seed from the cones in the woods, others ship the cones just as they are gathered, and the nurseryman or seed dealer removes the seed from the cones. This is rather a simple operation in most varieties providing you have the proper equipment, which consists of trays and a room, steam heated, where the temperature can be forced and held for eight to ten hours at 140°, the temperature necessary to force the cones of Pinus Banksiana to release the little seeds.

YIELD FROM THE CONES

The yield of seeds depends upon the quality of the cones, the thoroughness of drying and extracting and the manner of cleaning. There is a great variation in the yield of seeds from a bushel of cones. The cones of any species fill better during a "seed year" than during "off years," so that in the former there is greater bulk, and especially greater weight of seed.

CUTTING TEST

The usual test for quality of conifer seed made by the propagator is what is known as the cutting test, which merely means counting one hundred seeds and cutting them with a sharp knife. This will determine the percentage of sound seed, but it will not disclose

their power to germinate. Many seeds will show sound germs which, for some reason, will not have the power to germinate.

The result of extensive germination tests has developed that most conifer seeds will respond to the treatment and show a sufficient germination in 30 days to determine the quality of the seed. Some varieties, however, with hard shells like *Pinus Cembra* and *Pinus Coulteri*, require from 100 to 200 days to show their growing power.

THE TREATMENT OF SEED

Now, after we have secured our yearly requirements, in each and every variety of conifer seed to take care of our annual planting, we have reached the point where it is necessary to give some thought to the treatment of seeds before planting. The method of sowing and more especially the treatment of seeds before sowing is of great importance. Generally speaking, the practice of causing the various seeds to germinate before being sown will insure the successful culture of many varieties which, without treatment, are almost impossible to grow.

Steeping, sweating and stratifying are the various methods used to force the seeds to germinate. However, I will say from my experience in the handling and treatment of conifer seeds requiring treatment to force germination, that I prefer the slow stratification treatment to the quicker methods of applying artificial heat, which, together with moisture, causes steeping and sweating to stimulate rapid germination.

The usual method of stratifying seeds is to mix the seed with sand or soil, with a sufficient amount of moisture added to prevent drying. Store the seeds thus treated in a bin for a sufficient length of time to allow the germ to become well started. There is seldom danger of loss from seeds that have started growth in the stratification bin.

Through the skillful handling of the seed before sowing it is possible to obtain maximum results with a minimum of seed, which is the secret of the successful culture of nearly all varieties of conifers by experienced propagators. Many varieties of conifer seeds require a short period of treatment to prepare them properly for planting, while some varieties require a slow, careful treatment, lasting several months. Make frequent tests of the seed in the stratification bin; cut the seed lengthwise and examine carefully with a powerful glass. This will show you exactly what is taking place; if the germ is developing too rapidly, it may be necessary to remove

some of the moisture from the mass and lower the temperature. The object is to have the seed at just the right point for germinating at the proper time for sowing.

THE TIME FOR SOWING CONIFER SEEDS

For some varieties the best results are obtained from sowing the seed in late Autumn; others respond and give better germination when planted in the early Spring. However, in Spring planting the propagator must bear in mind that the little seedlings should be well above the ground before the hot sun of Summer is ready to beat down upon them.

THE BEST TYPE OF SOIL FOR SEED BEDS

Every propagator has his own idea regarding the proper soil for the production of coniferous seedlings. However, a visit to the nurseries located throughout the United States and Europe will show that coniferous seedlings are being successfully grown upon almost every type of soil, from a pure sand to a heavy clay. There is just one point to bear in mind, and that is that the soil must have good bottom drainage. It has always appeared to me that the treatment of the soil to put it in a proper condition for sowing was of as much importance as the type of soil itself. I want to emphasize the fact that the physical condition of the soil is of as much importance as the chemical composition.

In preparing the area which has been set apart as ground suitable for the production of coniferous seedlings it is necessary to have enough land to take care of an annual planting every year for five years. Under this system you will be in position to remove all the seedlings from a bed at the end of the third year, thus leaving the area vacant for the application of fertilizer or the growth of a cover crop to put the soil in fine condition to receive a second planting of seed. A soil may be rich with all of the necessary chemical elements but what the grower demands is that the soil can be readily worked. Therefore, the physical condition of the soil is of as much importance as the chemical composition.

WINDBREAKS FOR SUMMER AND WINTER PROTECTION

Plant evergreen windbreaks completely around the area selected for seed beds. Plant a single row of evergreens every 150 feet across the area, running parallel with the beds. These windbreaks temper the cold drying winds of Winter and assist in maintaining a more

uniform temperature over the enclosed area in the Summer. These windbreaks should take the form of neat, well-grown hedges, 6 feet to 12 feet high.

PREPARING THE SOIL

To put the soil in the best possible condition for the planting and growing of conifer seedlings one or more cover crops should be plowed under. Cow Peas or Red Clover gives very good results. The decayed vegetable matter keeps the soil from packing and furnishes plenty of food for the young seedlings.

It is a good plan, in fact it is very necessary, to thoroughly cultivate the area set aside for the seed bed, for at least one, or better, two years, before the sowing of the seeds takes place. Soil handled in this manner will be practically free from weed seeds, and this is a point of real importance in the production of seedling conifers; it is impossible to produce sturdy young seedlings and a crop of weeds on the same area. It is also a great deal cheaper to remove weeds with a harrow and a two-horse team a year or two in advance of planting than to weed the seed beds clean by hand after the young seedlings have started to grow. Of course, there will be much hand weeding necessary even when the soil has been given clean cultivation for the entire two years before planting. And right here I might add that it is mighty important in keeping the tender young seedlings free from weeds that the work is begun just as soon as the little seedlings appear above the ground. Do not let the weeds get a start. Weeding, of course, is only a detail, but is an important detail, it is only by giving the strictest attention to these seemingly unimportant details that we get the maximum results. It is seldom that any one great calamity happens; it is usually a lack of attention to a number of small details that causes failure.

THE SIZE OF THE SEED BEDS

The seed beds in most of the nurseries throughout Europe are 3½ feet wide by 65 feet long. I have never been able to find out why this size was uniformly adopted by the growers of Europe. I infer, therefore, that the size of the seed bed is of minor importance. However, it is necessary that you have a standard size for all beds to facilitate the keeping of the necessary production records. I have therefore based my operations upon a standard bed 4 feet wide and 176 feet long. The four-foot width is made necessary by the fact that the standard lath used for making the rack shades

comes in four-foot lengths. The length of the bed was determined by the fact that part of the labor, which is the plowing of the soil, is accomplished by horse power, which necessitates longer beds than would be necessary if only man labor was used.

MAKING THE SEED BEDS

Three such beds are made end to end. If a bed of shorter dimensions were used it would mean lost motion and wasted area. One straight, deep furrow is plowed across the entire 528 feet covered by three beds. The labor required is two teams for the plowing and 15 men for raking, five for each bed. As soon as the furrow is plowed, the men rake the ground smooth and level. This raking takes place as fast as each single furrow is plowed. It is much more satisfactory to rake each individual furrow, as it is plowed, than to wait until the whole four-foot area has been plowed over and then attempt to rake it down smooth and level. After the beds have been raked and re-raked until each small lump of earth has been broken and leveled, the surface should be as level as a table top and free from unbroken lumps of soil.

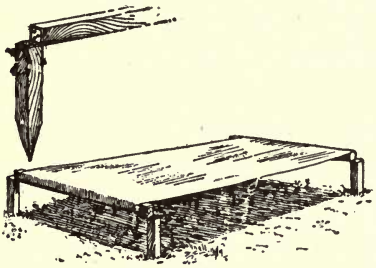

Fig. 8.—Convenient shading for young seedlings, especially shrub and evergreens. Note that frame is hinged so that it can be turned back when watering or caring for the plants

SOWING THE SEED

After ascertaining the germination percentage of the seed to be sown it is necessary to decide how thick to sow it, reckoning on the basis of so many seeds to the square foot, depending on the variety and the length of time the seedlings are to be left in the seed beds. For instance, take some of the Piceas. With a maturity period of three years and assuming that they will reach an average height by that time of six inches to eight inches, one square foot of ground will accommodate about one hundred plants, and seed should be planted accordingly, or the seedlings thinned to that number while small.

The seed is sown by two men, one on each side of the bed, each sower covering one-half of the area. After the seed has been sown it is firmly rolled with a wooden roller to insure every seed coming

into direct contact with the soil. The seed is now ready to be covered. The usual rule in planting conifer seed is to put the covering on twice the diameter of the seed. This operation we used to do by hand, using clear sand, the men taking it from pails and putting it on the beds. We now make use of a specially constructed machine, which is drawn from one end of the bed to the other by horses, sprinkling the sand evenly to the desired thickness.

In Europe the surface of the seed beds is left rounding, but I have found that when this is done germination is greatly retarded along the edges of the bed, therefore I use only the flat surface system. Moreover, the lath shades which are sued for covering fit more closely and evenly over the surface when it is flat.

SHADE FOR THE SEEDLINGS

After the seeds are sown, rolled, and the beds covered with sand, the lath shades are placed over the beds. These shades are four feet square, and the laths are nailed to two-inch cleats, leaving space enough between each two laths to allow another lath to be laid without nailing; thus when the rack is lying flat on the ground with the loose laths in place, it completely covers the newly planted seeds with a little wood roof.

It is important and necessary that these racks be placed over the seeds as soon as planted. It is a strange fact, but nevertheless true, that germination takes place more rapidly and more evenly in total darkness beneath the rack than when the same seed planted under the same conditions is allowed the full light of the sun. This lath covering also acts as a roof to keep the pelting rains from disturbing the surface of the newly made beds. If all goes well, the seed of most conifers will start to germinate in the Spring, in from one to three weeks. The little seedlings push through the soil, growing up toward the light The lath shade is now raised one inch above the surface of the ground and left in this position until all of the seedlings have grown high enough to touch the lath. The shades are then raised to a height of ten inches, and placed on pegs driven into the ground. Most varieties of conifers now demand a little more sunlight. It is therefore necessary to go over the beds and remove the unnailed laths. The seedlings are now protected from the sun and driving rain by a four-foot rack shade, with the laths nailed one and a half inches apart. This gives the seedlings what is known as a shifting shade; the shade moves as the sun travels across the sky.

To some, perhaps, these details are rather uninteresting, but to the grower of young seedlings, who strives for maximum results, each and every one of these operations must be given careful consideration.

WATERING

The watering of the young evergreen seedlings is an essential operation, and anyone considering the culture of conifers on a commercial basis must first arrange for plenty of water accessible to all parts of the seed bed area. The water is not used as a means to force added growth to the seedlings; it is an insurance against prolonged and severe drought at a time when the seeds are germinating. Some seasons not a drop of water will be required, the rains coming at just the right time to give the necessary moisture to induce the maximum germination. The next year's conditions may be just the reverse, and after the seed is planted and the time for germinating at hand if the weather is dry, the seed will germinate poorly if not supplied with moisture at this time. Therefore, it is necessary that the water be available when it is needed, otherwise the seed beds will be uneven.

THINNING THE SEED BEDS

The plan followed is to plant the seed thick enough to insure a heavy stand; the theory is that if the young seedlings come too thick they must be thinned to the desired quantity upon a given area. However, if they do not come thick enough, the growth is seldom good, due to the fact that the ground is not shaded by the young seedlings. Therefore be generous with your seed at planting time, knowing that if they are too thick they can be thinned, but if the stand is poor it never grows better. In fact, in the latter circumstance, the little trees seem to disappear and at the end of the second year most of them have succumbed to the elements. It may be necessary throughout the long, hot dry Summer to water the beds. If watering is necessary, it should be done in a thorough manner. Soak the ground so that water reaches down to the roots of the seedlings. It is best applied in the late afternoon or evening, in fact we usually water the seed beds during the night. This prevents the sun from burning the seedlings while the foliage is wet

DAMPING-OFF OF CONIFEROUS SEEDLINGS

Many seedlings of conifers are killed by the damping-off fungus even before they make their appearance above the seed bed. Poor

germinations are frequently due to this cause rather than to inferior seed.

Useful facts are given by Hartley and Pierce in "Professional Paper No. 453" of the United States Department of Agriculture, of which bulletin the following is the summary:

(1) By damping-off is meant the killing of very young seedlings by parasitic fungi. It is the most serious difficulty encountered in raising coniferous seedlings.

(2) To decrease losses from the disease excessive moisture and shade should be avoided. Caution must be used in following this recommendation or many seedlings may be killed by drought or by white-spot injury to the base of the stem. Damping-off can often be decreased by putting beds on very sandy soil. Seed should not be sown any thicker than necessary. It appears better to sow broadcast than in drills. Late Fall sowing results in decreased losses at some nurseries and is worth trial. Proper attention to all of these measures will decrease the losses from damping-off, but at most nurseries they are not sufficient really to control the disease.

(3) The addition of lime, wood ashes, and in some cases nitrogenous fertilizers seems to increase damping-off. Soil alkalinity appears to favor the disease. No effect has been noted from green manures. The use of unrotted stable manure has had very bad results; properly rotted manures seem less objectionable. Tankage, charcoal, and cane sugar are the only non-disinfectant substances which have to date given any hope of disease control.

(4) Soil disinfection has so far proved the best method of combating damping-off. Of many methods tested, treatments with sulphuric acid, copper sulphate, zinc chlorid, and formaldehyde have proved the most satisfactory. The disinfectants, however, behave quite differently at different nurseries. The acid has on the whole given the best results. Heat disinfection has been only partly effective. Disinfection by acid or copper sulphate is cheaper than by the other methods commonly recommended.

(5) In addition to decreasing damping-off after the seedlings come up, the chemical disinfectants above mentioned, when properly used, cause an increase in the apparent germination and are very helpful in controlling weeds. This latter effect alone at some nurseries pays the entire expense of the treatment. Sulphuric acid has, furthermore, at some places resulted in marked increases in the late season growth of Pines.

(6) In some soils formaldehyde kills dormant seed, and the other three most satisfactory disinfectants at some nurseries kill the root

tips of germinating seedlings. By proper precaution, all such injury may be prevented.

(7) The results obtained to date show that it is entirely possible and practicable to control damping-off by soil disinfection. Unfortunately, the varying behavior of disinfectants at different places renders it impossible to recommend any single treatment which will be everywhere successful.

BROAD LEAVED EVERGREENS

Rhododendrons (p. 210), Kalmias (p. 199), Andromedas (p. 183), Callunas (ps. 174, 187), Ericas (p. 69), and Azaleas (p. 183), are best sown in a mixture of peat and sandy loam over which is placed a thin layer of screened sphagnum moss. The seed is sown on the moss and covered by glass. A temperature of about 55 degrees should be maintained.

When the seedlings attain some size they are transplanted to frames out of doors and in the Winter given shading and protection.

DIŒCIOUS PLANTS

The following plants have the two sexes on separate plants, and are called *diœcious*. Unless both sorts of plants are in close proximity no seeds nor fruits are produced.

Ailanthus. Male flowers have objectionable odor; only female trees should be propagated.

Aucuba. The female flowers should be fertilized with a camel's hair brush. The charm of the plants is heightened by the attractive red berries.

Broussonetia. Male plants produce flowers in pendulous catkins, greenish in color; female plants produce the flowers in globular heads, showing purplish hairs until August, when the surface becomes dotted with orange pustules a quarter of an inch long.

Cercidiphyllum. Both male and female flowers are very small; inconspicuous. The female tree is more beautiful, being very spreading; the male is columnar, according to F. Canning.

Chionanthus. Only certain plants bear fruits.

Cycas. The male flower is a cone-like structure; female flowers are clusters of modified leaves. (See figs. 9 and 10.)

Elæagnus. Certain bushes are sterile, although the flowers bear both sexes.

Garrya elliptica. Greenish white male catkins; ornamental. Black berries are also showy.

Ginkgo. Male trees only should be propagated; female fruits smell badly.

Hippophaë. Without both sexes planted together, the beautiful fruit display is lost.

DIŒCIOUS PLANTS—Concluded

Fig. 9. — Female flower of Cycas revoluta. The ovules are borne in the notches of the deeply cut, modified leaves

Ilex. Holly. In some Hollies the flowers are fertile; in others, plants of both sexes are necessary if berries are to be formed.

Maclura (Toxylon). The sterile flowers are in racemes, the fertile are crowded in a large spherical head.

Morus. Mulberry. Usually monœcious; both sorts of flowers in catkins.

Phellodendron. Flowers greenish and inconspicuous, but the fruit is berry-like and hangs through the Winter.

Shepherdia. Plant both male and female plants for fruit.

Skimmia. Flowers are often diœcious.

Zanthoxylum. There is little difference in the ornamental value of male and female trees.

Idesia. Flowers are greenish yellow; fragrant. Male flowers ½ inch across; the female flowers ⅓ inch. Fruit in September. Orange red and very showy when leaves are gone.

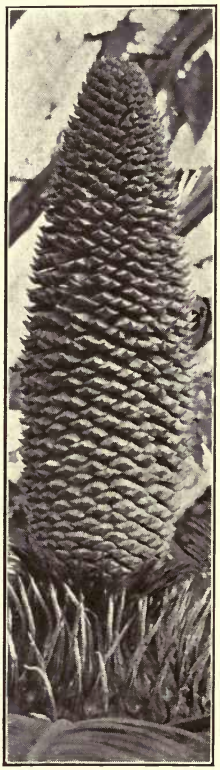

Fig. 10.—Male flower of Cycas revoluta. Globular pollen sacs are found on the lower side of each scale

SAVING SEED FROM DESIRABLE PLANTS

The normal flower of most plants has two parts or groups of parts—the male part (see fig. 11) made up of the stamens which are the pollen bearers, and the female part, consisting of the pistil which

has an ovary at its base which will bear the seeds. A flower may have brightly colored petals, but these are not directly necessary for seed production.

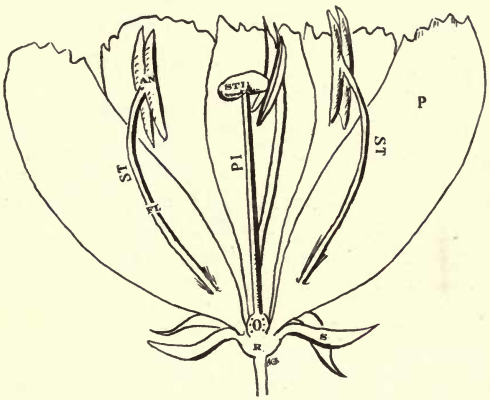

Fig. 11.—Section of typical flower. P, Petal, all the petals taken together is the corolla. S, Sepal, the sepals taken together is the calyx. ST, Stamen, the male part of the flower; AN, the pollen producing part or anther; FI, the filament or thread-like portion. PI, Pistil, the female part of the flower. STI, its sticky stigma which receives the pollen; O, the ovary which bears the seeds. R, Receptacle, a portion often making part of a fruit.

For every seed which grows in a seed pod at least one pollen grain must have landed upon the pistil. In the orchid, in which thousands of seeds are produced, thousands of pollen grains must lodge upon the pistil.

Some plants do not need to be crossed or pollinated; as examples, Beans, Sweet Peas and such flowers are so constituted that the pollen is shed on the pistil and seed is formed. In the Cucumbers and Squashes certain flowers are male and others are female. (See fig. 12.) No seed is produced unless the wind, a bee or a man places some pollen from the male flower upon the pistil of the female. In other words, the flowers which some persons have called sterile flowers in the Cucumber are just as essential as the other flowers. In the Corn plant the pollen is produced by the tassel and falls on the silks; any silk which does not receive a grain of pollen fails to produce a kernel of Corn.

When the grower notices a particularly superior plant, let us say a fine Cyclamen of good color and excellent habit, the best method is to take some pollen from one flower and place it on the

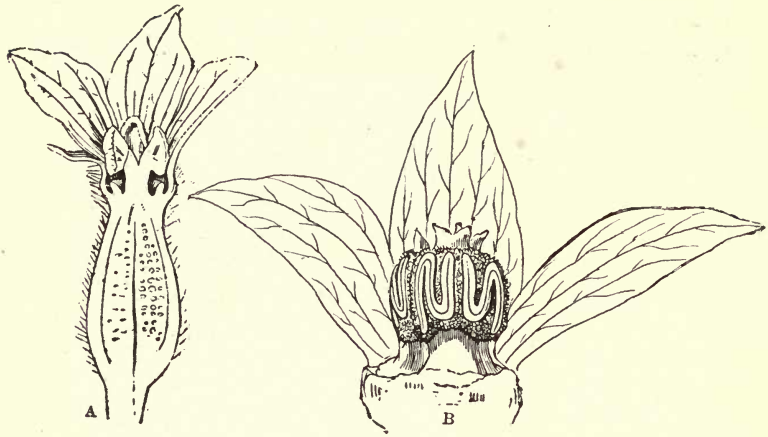

Fig. 12.—Squash blossoms. A, The female flower; note the bulge beneath the corolla; this is the undeveloped Squash. B, The male flower. All such plants as Melons, Cucumbers, Gourds and Pumpkins bear these sorts of flowers (See page 57)

pistil of another. It is best not to depend on its producing seed without this "artificial" pollinating. Pollination may be accomplished with a camel's hair brush, or the whole staminate flower may be picked and shaken over the other flower.

Better results will be attained by most persons if the above method is used rather than an attempt to cross two different plants. Crossing diverse plants will give surprising results, but they are not always commercially valuable. Hybridizing is a different process from saving seed of a known good variety. The good variety may, frequently, be intensified by "crossing it upon itself."

In saving seeds of Asters, Cinerarias, Gerberas, Calendula, Cosmos, Ageratum and all the Daisy-like flowers, merely place a bag over the flower and it will ripen its seed without crossing. Each Daisy-like flower (see fig. 13) is really a bunch of small flowers which will shed pollen upon each other.

Do not make the mistake of saving seed of Lettuce, Radishes or Celery from any plant which goes to seed too rapidly. It is apt to inherit this quality. The fact that the Radish often goes to seed rapidly is associated with its failure to produce a good root. We grow Radishes for the root, not the seed.

Seed should thoroughly mature before it is gathered and must be kept rather cool in storage.

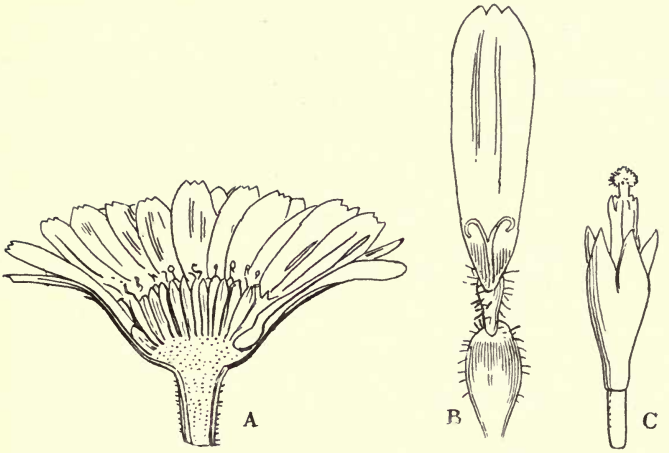

Fig. 13.—A Daisy-like flower. A, A head of Pot Marigold. Note that this is not a single flower, but a bunch of small florets, the showy sorts at the outside are ray florets; those toward the center are tubular and called disc florets. The ray florets are often only female flowers, but the disc florets are bisexual. B, A ray floret. Note the two forked stigma of the pistil, the single petal and the large ovary. C, A disc floret. Note the feathery stigma of the pistil; the ring of stamens surrounding the pistil, and the five parted corolla (See page 58)

POLLINATING TOMATOES

In the Tomato the stamens form a ring (see fig. 14) surrounding the pistil which protrudes beyond them. In bright sunshine, the blossom opens, the stamens ripen their pollen and shed it. It is a simple process to hold some sort of small wooden spoon beneath the flower. Then tap the flower with the other hand. The pollen will be shed into the spoon and the pistil may be carefully dipped into the pollen.

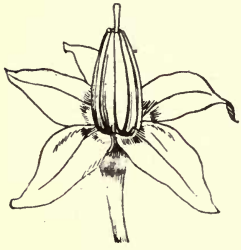

Fig. 14.—Tomato blossom. Note the ring of stamens surrounding the pistil

When Tomatoes are forced, artificial pollination of this sort is necessary. The worker goes through the house about noon and pollinates all flowers which are open. If the Tomatoes are being grown during the Winter it will be found that on sunny days more pollen is produced. On these bright days the pollen should be put in a small glass bottle and used during the sunless period; pollen will keep, in a bottle lightly corked, for several weeks. In the Springtime hand pollination is not necessary if the vines are vigorously shaken.

Certain varieties may be pollinated by the slightest jar of the vines. Bonny Best rarely requires hand pollination except in the dullest weather.

POLLINATION OF CUCUMBERS

Hand pollination of Cucumbers is a laborious process so that bees are often used for the purpose. C. W. Waid advises a strong hive to a half acre of Cucumbers. The bees are often restless when first placed in the house, but soon become quite at home.

CHAPTER II

CUTTINGS

WHAT THEY ARE—The Wood to Use—The Rooting Medium—Inserting Cuttings — Temperature — Damping-off — Callus — MONOCOTYLEDONOUS PLANTS—POTTING CUTTINGS—SAND AND WATER METHOD — PROPAGATING CASE — DARLINGTON'S PROPAGATING FLATS—CHEMICAL TREATMENT TO HASTEN ROOTING—FLORISTS' TIME TABLE—PERENNIALS—HARD WOOD—EVERGREEN CUTTINGS —Greenhouse Propagation—Making—Planting—Care—Outdoor Frames—Soft and Half-ripe Wood—SUMMER CUTTINGS OF SHRUBS Greenhouse — Frames — LARGE STEM CONSERVATORY PLANTS— LEAF—ROOT.

Fig. 15.—Condition of wood for cuttings. Note that in making soft wood cuttings certain portions of the stem are brittle and break with a snap; this is the best part to use. Wood that is hard and stringy does not root as readily (See page 62)

ANY part which has been severed from a plant is a cutting. Propagation by slips or softwood cuttings from the stems of plants is the simplest method, although root cuttings and leaf cuttings are frequently advisable.

There are both "cuttings" and "rooted cuttings" and the two terms should not be confused in either giving or receiving orders. A rootedcutting is practically an established plant, whereas a cutting is a mere slip.

Cuttings or slips are taken of most commercial plants because this is a rapid method of propagation and because it insures a new plant true to variety. No

such dependence can be placed on the growing of stock from seeds. Favorable stem, leaf and flower characters are perpetuated exactly as in the parent plant. Some plants, too, produce no seed; these must be propagated by some other means, such as cuttings.

THE WOOD TO USE

A stem from which soft wood cuttings are to be made should be brittle, not stringy; when bent it should snap, not bend. (See fig. 15.) If too full of sap the cuttings damp-off readily; if too old, they are slow to root. The best material is the first one to three inches of the tip of a shoot. Two or more eyes should be found on each slip. The cut should preferably be made through an eye at the base, although many plants will root from cuttings made at other points than an eye or node. A Clematis cutting, for instance, will root better when cut at an internode. The growth activity is considered to be greater at the nodes and rooting at those points should ordinarily be more sure. The cutting will have no roots with which to supply food and water to the leaves, so that most of the latter should be removed or much shortened. It will be the food stored in the stem and remaining leaves which will produce the new roots.

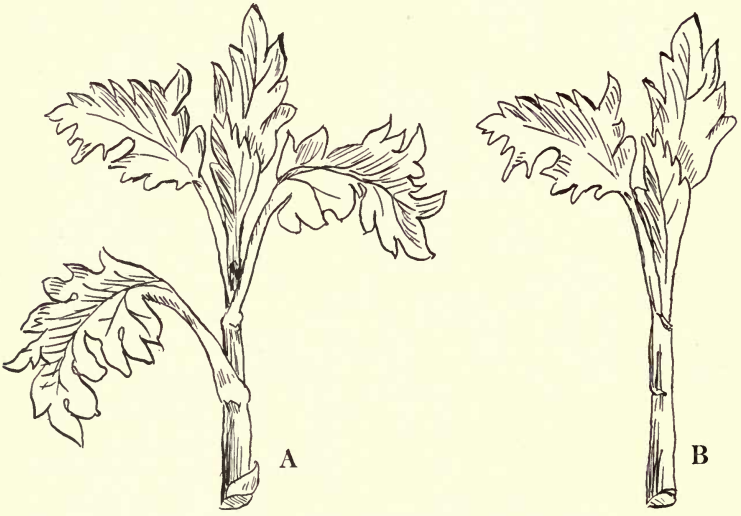

Fig. 16.—A—Chrysanthemum cutting. This is untrimmed as cut from the plant B—Chrysanthemum cutting. The two lower leaves are removed to reduce the loss of moisture from the cutting. Note that the cut at the base of the cutting is through an eye, or node; it is, therefore, called a node cutting (See page 145)

Some propagators argue that the leaves should not be removed, because the lower ones aid in the manufacture of food and they, as well as the stem, may root. If the leaves are not removed the cuttings should be placed in a Wardian case or under a bell jar. By retaining the leaves the cutting is saved the effort of healing the wounds necessarily made. For some species it will be best to remove most of the leaves, and for others it will not be advisable to disturb them in any way.

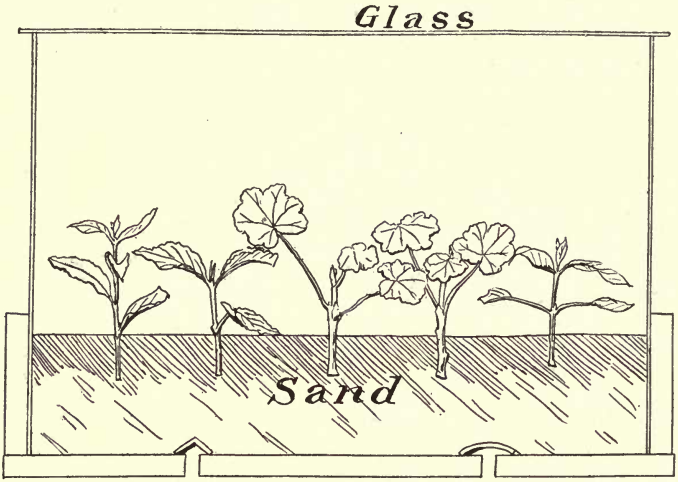

Fig. 17.—Propagating case. Shows cuttings inserted in the sand of a propagating case. The glass at the top confines the air. Such a case is useful in propagating many conservatory plants

Most amateurs blunder by desiring a large plant at the start and failing to shorten the cuttings enough. In other words, too long a cutting will be difficult to root and may make an unshapely plant. Never allow flower buds to remain on a cutting; they will only exhaust its vitality.

As soon as the cuttings are made they should be dropped into a pail of water or wrapped in moist paper to keep them fresh. They should not be kept in the water too long, however, else the bark will be loosened. From time to time, as sufficient cuttings are made, they should be placed in the cutting bench.

Half-ripe wood is a term applied to material used in propagating shrubs, principally. It designates that condition of the stem between soft, new growth and the hard, woody condition of Winter.

THE ROOTING MEDIUM

Coarse sand, free from all organic matter,* has proved to be the best material to use in rooting cuttings. The sand furnishes good aeration and drainage, but at the same time it allows for a free passage of water up from below. To eliminate danger from diseases the sand is usually sterilized. An easy way to sterilize sand is to load it into a metal wheelbarrow and take it into the boiler-room where a pipe may be run from the boiler well into the center of the load. Cover the sand with heavy carpet to retain the heat. Allow steam to run into it for a half hour to one hour. (See also damping-off fungus, page 65.)

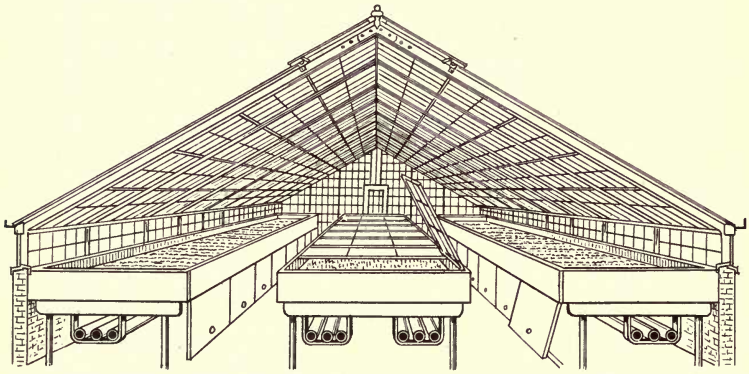

Fig. 18.—A propagation house. The roof should be shaded. The benches are boarded in below to retain the heat, an advantage in maintaining a higher temperature in the sand than in the atmosphere. The sash-covered center benches may be used for propagating such plants as require a confined atmosphere. By building up the benches and covering with glass, this house could be used for grafting Roses

Before the cuttings are inserted the sand should be thoroughly watered and tamped, or pounded hard with a wooden mallet or brick.

INSERTING CUTTINGS

By means of a straightedge and a large, heavy knife, a groove is cut into the sand. The cuttings are inserted and the sand packed around them tightly. The commercial method is to place all the cuttings in the rows first, then, with the fingers, compact the sand about them. The straightedge is then placed along the rows and several raps of the mallet serves to further set the cuttings firmly.

* The presence of organic matter supplies a medium for the growth of injurious micro-organisms; as Prof. O. F. Curtis points out, these organisms exhaust the oxygen in the rooting medium, thereby weakening the cuttings.

Unless cuttings are so treated the air will get into the sand, and the base of the cutting will dry. After setting the cuttings, water them thoroughly and cover them with newspapers or a cheesecloth screen.

THE ROOTING TEMPERATURE

To induce root action rather than top growth, it is agreed that there should be some sort of bottom heat; that is, the temperature of the sand should be greater than that of the air. In greenhouses this is attained by running several pipes under the cutting benches. For Summer rooting out of doors, hotbeds may be used and fresh and fermenting manure employed as the source of heat. The florist and nurseryman prefer to have a difference of from 5 degrees to 10 degrees between sand and air.

DAMPING-OFF FUNGUS

The "damping-off" fungus is often encountered in the cutting bench. The cuttings decay at the surface of the sand, the tops often remaining green some time after the stem has blackened. Excess of water in the sand or air favors the spread of the disease. A higher temperature than the plant requires and close conditions are other factors. Formalin, used at the rate of one part formalin to fifty of water, using two quarts to a foot of sand, will kill the fungus, but the cost is rather prohibitive. Allowing the sun to enter the house and letting the bench become rather dry, will help control it when the plants are in the bench. It is suggested that peroxide of hydrogen be used to supply oxygen to the sand and air. Definite proportions have not been accurately determined.

THE CALLUS

When a cutting starts to root it gradually produces a layer of spongy tissue over the cut surface. This is a callus and usually precedes rooting. Conditions which favor callus formation also favor root formation. Good callus formation, therefore, indicates that conditions are proper. Leaf calluses form on the veins (note fig. 25). The callus is first a wound protection, but later the cells are absorptive and even go so far as to produce organs lost as a result of the wounding.

MONOCOTYLEDONOUS PLANTS

The monocotyledonous plants, such as the grasses, Lilies, Asparagus and Aroids, root in a different way than the dicotyledonous plants. A callus is rarely formed, but the cut surface becomes corky

in appearance. No roots are sent out from the stem, but one of the buds in the axil of a lower leaf enlarges and sends out roots. The bud continues to grow and becomes the new plant; the cutting soon withers away, and the new plant is independent. *Cyperus alternifolius*, the Umbrella Plant, is most easily propagated by cutting the stem off an inch below the head of leaves which are shortened and tied together in a bunch. The cutting is then inserted in the sand below the point where the leaves arise from the stem. Young shoots start from the eyes but the stem does not root. The rooting of monocotyledonous plants is, therefore, analogous to the germination of seeds. The germ of a seed has the ability to produce leaves and roots; so has each eye in this large group of plants.

POTTING CUTTINGS

Most plants should be potted or transplanted before the roots get a half-inch long, using small pots or flats and friable, not too rich soil. Allowing the cutting to remain in the propagating bench will be detrimental, because after it has used up its own stored food, it can get none from the sand. Cuttings which are not well rooted when potted may be set at the side of the pot instead of in the center. Here thereby they receive better aeration through the pores of the pot. Certain plants, Clematis for example, have a tendency to produce a great deal of callus but roots may be slow in appearing. By paring off some of the excess callus, you may induce the growth of roots.

THE SAND AND WATER METHOD OF ROOTING CUTTINGS

By the sand and water method many a tree may be rooted which it is difficult to increase in other ways. It makes use of a pan, or a pot with the hole closed, filled with sand. Half-ripened wood is used for the cuttings and placed in the pot. The sand is kept in such a wet condition that the water is almost visible on its surface. The pan or pot can be placed in the sun after the first few days, the excessive moisture prevents wilting, and rooting soon takes place. *Gordonia pubescens* is rooted by this method.

PROPAGATING CASE

Every conservatory and general flower growing establishment should have a frame in the greenhouse, in which the atmosphere can be confined and good bottom heat maintained. This sort of case is often known as a Wardian case but others mean by Wardian case a box for growing rather than propagating plants.

Robert Shore, gardener in the Cornell University Department of Botany, has devised a sash-covered frame which is maintained at a relatively high temperature by boarding up the heating pipes. A pan of water sets upon the pipes and tends to equalize the temperature. The bottom of the frame is provided with a number of holes to allow for the free passage of the heat upward. A layer of three or four inches of sphagnum moss over the holes serves to retain the moisture.

Many plants, such as Crotons, Dracænas, Nepenthes and other tropical plants, are readily propagated in such a frame. Mr. Shore propagates these plants successfully by placing the end of the cutting through the drainage hole of an inverted empty flower pot placed upon the moss. The roots start in the moisture-laden air inside the empty pot.

DARLINGTON'S PROPAGATING FLATS

H. D. Darlington in THE FLORISTS' EXCHANGE of April 22, 1919, described a simple propagating box which will be found useful for rooting cuttings of many sorts of greenhouse stock:

"Take ordinary flats—those from the tin factories, 10 inch by 20 inch by 3 inch deep are just right—whitewash inside and after they are dry put into each one inch of clean cinders or broken pot covered with salt hay; or, if you are not near the coast, straw or litter will do; this material is a great help with regard to drainage, as it keeps the sand from working into the cinders. Fill the flat with sand, of which you will have a depth of about 1½ inches. See that the sand is clean and sharp.

"Now cut glass six inches wide and in lengths so that it will go around the box. With a broad putty knife open a slot around the edge of the box, set up the glass, pound the sand firm, and you will have a glass lined box with the glass standing about three inches above the sand. A 12-inch by 24-inch light of glass will cover this nicely. I have found this better than the old fashioned bell glass, for, as the glass in the flat never fits perfectly tight, you get enough air, and there is less danger of damping off; at the same time this arrangement answers all the purposes of the bell glass. Another advantage is that the 10-inch by 12-inch boxes may be set one right next to the other, so that no room is lost.

"A north side propagating house is the ideal, but any good, light side bench will answer. It is better not to shade the house over the cuttings, but take muslin the width of the bench in 10 feet or 12 feet lengths and tack a lath at each end; this arrangement can be quickly

rolled out over the boxes when they need it, which is usually from 9 a.m. to 4 p.m. At other times of the day, however, and on cloudy days the cuttings are better off for all the light possible. A safe temperature is 50 degrees to 55 degrees."

CHEMICAL TREATMENT TO HASTEN ROOTING

In conducting some experiments along other lines, Prof. Otis F. Curtis* found that certain chemicals actually hastened the rooting of Privet (Ligustrum ovalifolium). This aroused his interest and he tested the effect of various chemical treatments in this direction. He found that potassium permanganate was useful for hardwood cuttings because (1) the treatment causes a change in the nature of the food supply of the twig; (2) it affects the rest period, causing growth to start sooner than it normally would; (3) it upsets the balance of food supply between tops and roots in favor of the latter; (4) it retards the growth of micro-organisms; (5) it increases respiration by hastening oxidation. It was found that treating the cuttings for twenty-four hours with a 1 per cent solution of potassium permanganate was beneficial. Fifty-two different treatments were given the cuttings and all gave better results than where no treatment was made, except when a too weak or a too strong solution was used.

In other experiments soft-wood cuttings of Tomatoes were used, it was found that a sugar solution was beneficial. Placing the cuttings in a 5 per cent solution of cane sugar for one or two days proved best. The cuttings transform the sugar into starch and rooting is hastened. When a sugar solution is used the terminal bud does not develop, but buds lower down grow more readily. The cane sugar treatment increases the danger of injury from bacterial decay, and this should be taken into consideration.

FLORISTS' TIME TABLE FOR CUTTINGS

Abutilon. Flowering Maple. Autumn. Soft wood. 55° to 65°.

Acacia. June or Winter. *A. longifolia*, *A. heterophylla*, *A. puchella*, *A. spiralis*, *A. platyptera*, *A. hispidissima* and *A. pubescens*. Half-ripe wood; not over 1½ inches long. Take 6 weeks to 8 weeks to root. Pot as soon as rooted as roots become brittle and are difficult to transplant. 60° to 70°. (See Darlington's Propagating Flat, page 67. Also *Erica*, p. 69.)

Acalypha. Autumn to Spring. 60° to 70°.

Agathæa (Felicia) (Blue Daisy). 55°. Autumn and Spring.

* Curtis, Otis F. Stimulation of Root Growth in Cuttings by Treatment with Chemical Compounds. Memoir 14, Cornell University Agricultural Experiment Station.

Ageratum. February to March. 60° to 65°.
Akebia. Midsummer; half-ripe wood. Winter; hard wood. 45°.
Allamanda. In Winter or Spring when pruning use ripe wood; soft wood for heel cuttings. Give a little bottom heat. Place cuttings in thumb pots of sand and leafmold. Three weeks to root. 60°.
Aloysia. (See Lemon Verbena.)
Alternanthera. August. Place in sand. When rooted place in flats. Pot in April for sale. 60°. Or plant in deep boxes setting plants deeper than in field. Then divide plants in March and pot them.
Antirrhinum. (See Snapdragon.)
Araucaria (Norfolk Island Pine). (See page 143.)
Ardisia. (See page 144.)
Aucuba (Gold Dust Tree). Summer to Autumn. Half-ripened wood. Use long cutting. 50° to 60°.
Begonia. (Lorraine group.) Before January. Usually leaf cuttings. 65° to 70°. (See page 81.)
(Winter flowering type.) April. Two inches long. Root in propagating case. Place three or four in 3-inch pot.
Baronia. (See method advised for Erica.)
Bougainvilla. Early Spring. Half-ripened wood. 60° to 70°.
Bouvardia. March. After cutting back plants and resting them. Heel cuttings seem best. Stem cuttings more difficult than root cuttings. 60° to 65°. (See page 84 for root cuttings.)
Buddleia. Summer; soft wood in greenhouse. Autumn; hard wood. Keep out of danger of frost over Winter.
Camellia. Late Summer. Ripened wood. Root in sandy peat. 60° to 70°. Often grafted.
Carnation. (See page 145.)
Chorizema (Tango Plant). Winter or early Spring. May be rooted in sand bench or in pots in mixture of sand and leafmold. Place in propagating case or under bell jar. 65° to 70°. H. D. Darlington uses hard-wood cuttings and advises November and December before young growth starts. Believes that covering with glass causes damping-off.
Chrysanthemum. (See page 145).
Codiæum (Croton). November to February. Use bell jar or propagating case. 75° or above. Bottom heat. (See page 67.)
Coleus. September to Spring. 60° to 65°.
Croton. (See Codiæum.)
Cyperus (Umbrella Plant). (See page 66.)
Dusty Miller. Lift old plants. Take young growth. 50°.
English Ivy. August to September. Also from indoor plants in December to January. 50° to 55°.
Epiphyllum (Christmas Cactus). Use fresh sand and bottom heat; keep on dry side. Place in small pots of sandy soil. Do not take succulent shoots.
Erica (Heather). December to Spring. Take short cuttings from strong plants. Never above 60°. (See Darlington's propagating flat, page 67.)

Mr. Darlington describes the propagation as follows: "I like small cuttings about one inch long. Pull out the tip of the cutting; this destroys the flower bud and there is no danger of the latter developing in the cutting box. This precaution is especially important

with *Erica cupressiana;* it often means just the difference between a good strike and a failure.

"After your cuttings are made and put into the boxes water carefully and put in the house, every morning taking off the 12-inch by 24-inch light of glass. You will find the under side covered with condensed moisture. Allow the boxes to remain uncovered about one-half hour; then put back the glass *dry* side down. I have given up trying to dry the glass; it's not necessary; just reversing it will answer. Water as the cuttings need it; a dash with a fine rose spray every bright day and a good watering every six or seven days will usually be right. I like to pot the cuttings as soon as they are well rooted and not allow them to stand too long in the boxes."

Euphorbia. *E. fulgens* (*jacquinæflora*). Midsummer. (See Poinsettia page 161.)

Ficus (Rubber). Place cuttings in 2½-inch pots, tying leaves so they can be placed close together. Plunge pots in propagating case with bottom heat. 80°. Keep moist till rooted. Use compost of loam, sand and leafmold, equal parts. Single eye cuttings also may be rooted.

Fittonia. Early Spring. Pot in leafmold and sand in 2-inch pots. 65°.

Fuchsia. February to Spring. Use only newest wood from plants cut back some time previously. 50° to 55°.

Gardenia. December to February. Use soft wood. Keep close. 65° to 70°. Bottom heat. Root in three to four weeks.

Genista. December to February. Soft wood, young gowth with heel. 45°. Bottom heat.

German Ivy. January to March. 60°.

Heaths. (See Erica page 69.)

Hedera. (See English Ivy page 69.)

Heliotrope. January for Spring; July for Winter use. Soft wood. Root better from plants established in pots. 60°.

Hibiscus. Young growth. April. 65°.

Hydrangea. Usually take cuttings after blooming. Use small shoots at base of plant. Takes 11 to 14 months to bloom from cuttings. 50° to 55°. Slight bottom heat. (For hardy Hydrangeas see page 196.)

Impatiens. September to May. 60°.

Ipomœa. Bona-nox. See Moonvine.

Iresine. Mid-September. 60° to 65°.

Jasminum. Autumn and Winter. Ripened wood. 50° to 55°.

Jerusalem Cherry. Usually grown from seed but cuttings can be taken early in year.

Lantana. January to Spring. Green wood. 60° to 65°.

Lemon Verbena. February to April. Cut back old plants to force new growth. 50° to 55°. Slight bottom heat.

Linum trigynum. March. Plants set in open in May. Pinch for compactness. Pot in September.

Lobelia. Pot selected plants from field and propagate through Winter. Good habits and colors are perpetuated.

Marguerite. March for Spring sales. August for January pot plants. 50°.

Metrosideros. Half-ripened wood, with heel. Place in pots of sand; keep moist.

Moonvine. September. Keep cool. Continue propagating through Winter.

TIME TABLE FOR MAKING CUTTINGS—Continued

Nepenthes. (See propagating case, page 66.)
Nerium. Spring. Either sand or water. Keep moist and warm.
Olea. *O. fragrans.* Fall.
Pachysandra. Midsummer to Autumn. Green wood.
Pelargonium (Geranium). September to May. 56° to 60°. Because of softness of wood delay putting in Fall cuttings until just before a frost is expected. Fewer rot if sand is used for rooting them. Cuttings at this date make nice 4-inch stuff for Memorial Day. The fancy Pelargoniums, Easter Greeting and others, are best propagated immediately after flowering.
Poinsettia. See page 161.
Quisqualis (Rangoon Creeper). January. Bottom heat. 80° to 85°.
Roses. (See page 161.)
Santolina. January to early Spring. Soft wood. 50° to 55°.
Selaginella. Cuttings placed in pots in propagating frame.
Snapdragon. January to March. Many growers believe that seedlings make more florifreous plants, less liable to disease and with greater vigor, but finest varieties are kept true by means of cuttings—true to color and profusion of bloom.
Stevia. Cut back plants produce good cuttings in March. Stop pinching in August. 50° to 55°.
Swainsona. January to March. Green wood. Root 12 to 15 days. Pull out cuttings from axil of leaves. No trimming necessary. 50° to 55°. Keeps close.
Verbena. February to March. Green wood. 50° to 55°.
Vinca major. Autumn; or January to March. Half-ripened shoots. 60° to 65°. Can layer in field.
Violets. See page 172.

MAKING CUTTINGS OF PERENNIALS

Cuttings can be made of hundreds of perennials. If you wish to increase your stock, merely take little slips in the Spring when the plants are six or seven inches tall. Be sure to leave a few buds below where the cutting is taken; it will not injure the plants in the least, but will cause them to become branchy. Choose wood that is a little ripened.

Oftentimes plants are stored in pots in coldframes until December, then brought into a cool house. These plants furnish a good source of cuttings.

Some of the perennials which are readily propagated by cuttings are given here; others are found on page 174.

Ajuga	**Clematis**	**Larkspur**	**Phlox**
Arabis	**Dahlia**	**Lobelia**	**Pinks**
Asclepias	**Eupatorium**	**Loosestrife**	**Plumbago**
Boltonia	**Helenium**	**Lotus**	**Potentilla**
Centaurea	**Hesperis**	**Monarda**	**Salvia**
Cerastium	**Heuchera**	**Pentstemon**	**Sedum**
Chrysanthemum	**Hollyhock**	**Perennial Sunflower**	**Veronica**
	Iberis		

Fig. 19.—Dahlia cuttings. Such shoots make excellent material for cuttings, each one besides being of the proper length is also provided with a heel or "meat" at the base. Heel cuttings are thought to produce better tubers

In the Summer the cuttings may best be rooted in coldframes prepared much like the propagating benches in the greenhouse. Cheesecloth screens should also be erected over the frames. Care must be taken that the cuttings never dry out and the ventilation must be perfect. Damping-off is sure to result if the conditions are stuffy and moist. (See page 65.)

HARD WOOD CUTTINGS

Most of our shrubs and many of our trees may be propagated by hard wood cuttings. The wood of the last season's growth is taken in the Autumn or early Winter, when the leaves have dropped (preferably before heavy freezes) and cut into approximately six-inch lengths. The cuts at the base and tip should be through an eye, although this is not absolutely necessary except in hollow stemmed sorts. (See fig. 20.) They are usually tied in bunches of fifty or one hundred, and may then be placed in boxes of moist soil or sand in a cellar, or they may be buried upside down in a sandy knoll deep enough so that they are below frost. A mulch over the top will help retain the heat. Take special care to keep the tops all one way and have the butts in one plane so that they may callus uniformly.

Fig. 20.—Hard wood cutting. Note that the top is cut just above the buds, and that the basal cut is made through the buds. Such cuttings should range from 4 to 8 inches long

Early in the Spring the cuttings, which will have rooted, or at least callused, should be planted in rows far enough apart for cultivation, and 6 to 8 inches apart in the rows. They should be so planted that one or two eyes are above the surface of the soil. It is expected that 90 per cent shall root. In the Autumn they should be dug and sorted for size. Some shrubs will require replanting in the nursery row; others will be salable the first year.

The Climbing Roses are easily propagated by this method. Grapes and Currants are so multiplied; cuttings 5 to 7 inches long being sufficient. Some growers also use one-eye cuttings of Grapes. (See also Vitis, p. 222.)

Cuttings are often taken in the Spring, but they do not root so readily. The Fall cuttings produce their roots before their tops. Spring cuttings are apt to produce tops before roots and thereby use up the food which should go toward root formation. As root growth proceeds more slowly than top growth it would seem especially necessary to use bottom heat in Spring rooting.

EVERGREEN CUTTINGS

A very successful way to propagate conifers and broad-leaved evergreens is by means of cuttings which are placed either in out-

door frames or in the greenhouse. Many conifers do not come true from seed. Three types of cuttings are used: simple, heel and mallet. The simple cutting (see fig. 21) is the sort mentioned previously in the case of soft wood and hard wood cuttings. The heel cutting (see fig. 22) differs in one respect only, in that it has a small slice of the parent stem attached at its base. The mallet cutting (see fig. 23), as the name infers, has at its base a small or large piece of the entire stem to which it was attached. The two latter sorts of cuttings are thought to be better because of the food stored in the parent stem. Heel cuttings are especially useful in the case of those evergreens which root very slowly.

Fig. 21.—A simple conifer cutting. The cut shows a species of *Retinispora*. The leaves are cut from that portion of the stem which is to be placed beneath the surface of the sand

The following evergreens are commonly propagated by cuttings:

Andromeda. (See page 183.)
Azalea. (See page 183.)
Buxus. (See page 185.)
Calluna. (See pages 174, 187.)
Cotoneaster. (See page 191.)
Cryptomeria. (See page 192.)
Cupressus.
Euonymus. (See page 193.)
Hedera. (See page 69.)
Juniperus. (See page 198.)
Kalmia. (See page 199.)
Mahonia. (See page 201.)
Picea. (See page 206.)
Retinispora. (See page 210.)
Rhododendron. (See page 210.)
Sciadopitys. (See page 215.)
Sequoia. (See page 215.)
Taxodium. (See page 215.)
Taxus. (See page 217.)
Thuya. (See page 217.)
Thuyopsis. (See page 218.)

GREENHOUSE PROPAGATION

One of the best discussions of the propagation of conifers from cuttings was written by A. H. Hill and published in *The Florists' Exchange*, Aug. 23, 1919. It says in part: The greenhouse, more properly called the propagating house, should be a well planned, permanent structure with the heating pipes beneath the benches. Provision should be made for a supply of water and equipment necessary to furnish artificial light at night to permit the propagator to record the varying of the temperature and make the other inspections, both night and day, so necessary to the successful production of conifers.

Supply of sand. A good supply of sharp, clean sand is necessary for filling the flats in which the cuttings are rooted. This should be of fine texture to permit firm packing in the flats after the cuttings are planted. It should be absolutely clean from all dirt and vegetable matter to prevent the growth of fungus. The test for good propagation sand is made by adding a handful to a glass full of clear water. The

Fig. 22.—A heel cutting. The sketch shows a cutting which has been made so that a portion of the parent stem is attached to the base. This is a species of Juniper

right kind of sand will settle to the bottom of the glass without causing the slightest cloudiness in the water.

Cutting the wood. The usual time for cutting the wood for making into cuttings is in the Autumn when the growth is well ripened. It is well to wait until several good sharp frosts assure you that the wood is in a perfect state of maturity. Small branches are cut, using only the strong, vigorous shoots from the sides near the top of the plant. If the variety is a strong grower each branch cut will produce, when properly divided, several desirable cuttings. Do not cut the wood when it is in a frozen condition. Place the clippings in a basket or bag as soon as they are cut, to prevent their drying.

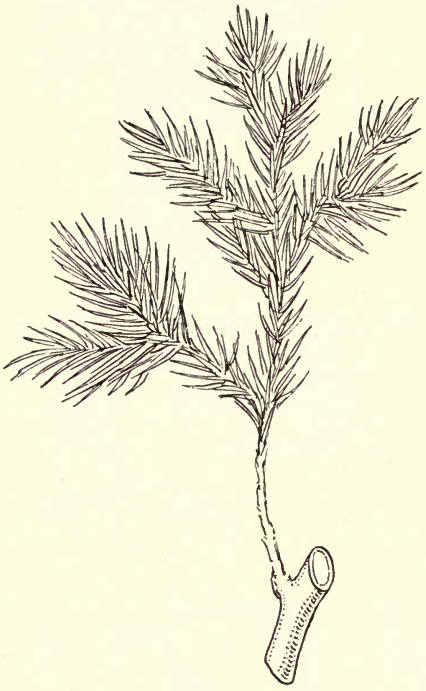

Fig. 23.—A mallet cutting. In making the mallet cutting a piece of the entire stem of the parent plant is left at the base. This mallet is a storehouse of food; such cuttings often root when the simple cutting does not (see page 74)

Making the cuttings. With nearly all varieties of conifers, in making cuttings, use only wood of the past Summer's growth. It does not matter whether it is a leader or side branch, just so it is firm and well matured. Remove all of the foliage from the sides of the cutting, leaving only a small amount at the top. Make the cuttings of a uniform length by cutting the bottom end of the stem with a light, sharp knife.* Cuttings of uneven length must never be planted in the same flat because the smaller ones do not receive the same light and air as the longer ones and are consequently smothered.

* Cuttings range in length from 3 inches to 8 inches long. They are often merely pulled off with a heel which is then trimmed with a knife.

Planting the cuttings. The cuttings are now ready for planting. Some propagators fill the benches with sand for the planting of cuttings, but I prefer a small flat, 24 inches long, 15 inches wide, and 3½ inches deep, made of light pine boards. Such flats can be removed from the house in the Spring when the cuttings are rooted and placed in frames on the ground out of doors where the fresh air and sunlight stimulates a more healthy root action.

In planting, each cutting is spaced ¼ inch to ½ inch apart in the row and space enough left between the rows to permit the air and sunlight to penetrate through the foliage down to the surface of the sand to prevent the growth of fungus.* A liberal supply of water is given the cuttings when planting is completed. This settles the sand firmly around the newly planted cuttings and the flats are then placed on the greenhouse bench.

Care of the cuttings while rooting. Give the cuttings a gentle bottom heat. Loss frequently results from lack of control of the bottom heat with newly planted cuttings. Further watering is not required until the sand in the flats shows dryness. Do not open the ventilators in the house until the cuttings are well rooted. Allow the full sunlight to fall upon the cuttings. Shade from the sun will not be needed until the late Spring and early Summer.

The cuttings of most conifers will develop calluses before the roots appear. Most of the Arbor Vitæ and Junipers begin the formation of a callus, soon after planting the callus completely covering the cut surface of the cutting.† Some varieties develop tender young rootlets as soon as the callus has formed. Other varieties wait for months after callusing before the roots appear, while some varieties, such as the *Juniperus virginiana* forms, which are unusually difficult to propagate from cuttings, remain in a well callused condition well into the second year before they form roots.

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* Van Cleef makes a suggestion as to setting the cuttings as follows: "The portion of the cutting which goes into the ground is cleared of all the small branches by simply stripping them off. Then the first finger of the right hand is placed in the center of the cleaned part of the cutting, and pressed into the soil, so that the cleaned part goes into the soil doubled up. Roots form freely on this bent part. Of some varieties of conifers, of which globular shapes also are grown as well as pyramidal forms, the future shape of the plant can be regulated by the way the cutting is made. If a pyramid is wanted, the top of the cutting should not be interfered with, whereas, to obtain a globular shape the top of the cutting is trimmed back severely. It is advisable to keep the cuttings quite dark, as roots form better."

† I. Bayley Balfour, in the *Journal of Royal Horticultural Society*, Vol. XXXVIII, Part III, pages 447-61, writes: "Evergreens often produce calluses very poorly but they all form some. The obstacle to the rooting is the resin which covers the cut surfaces and hardens. If the resin skin is scraped from the cuttings they will often form abundant callus. Should the callus become too large it may be pared down, in which case roots will be encouraged. In Pine the flow of resin is great; it is also thought very difficult to root from cuttings. The ends of the cuttings should be plunged in nearly boiling water; this seals the resin canals and the heat promotes the formation of a callus."

Care of the cuttings when rooted. After the cuttings have completed their rooting, which will be some time in June, they may safely be given a good supply of fresh air daily and an even coating of whitewash should be sprayed over the top of the propagating house to prevent any danger of sun scalding the tender young top growth which has developed.

The flats in which the cuttings are growing can now be removed from the house and placed directly on the ground in a partially shaded frame out of doors. The fresh air and sunlight stimulate good, healthy root action and reduce the danger of loss from decaying roots, which always causes serious loss throughout the Summer when cuttings are not given the most natural growing conditions. The cuttings must remain in the flats until the following Spring when they are in a perfect condition for potting or planting in beds.

Outdoor frame cuttings. Some varieties of conifer cuttings are successfully rooted in frames out of doors during the Midsummer and late Summer season. The frames are built slightly below the surface of the ground. The soil is removed from inside the frame to allow for one foot of stable manure for supplying the required heat. The frame should be constructed to prevent the entrance of air currents through any cracks or openings. The top of the board or concrete forming the sides of the frame must be level and smooth so that the glass sash fits perfectly. A light frame is built at a height of 4 feet above the top of each frame as a support for the muslin shade. Fresh stable manure is firmly packed in the bottom of the frame and soaked with water. This will supply steady, even bottom heat for the cuttings. The sand is now spread evenly in the frame to a depth of 4 inches and the frame is ready for cuttings.

Soft wood and half ripe wood cuttings. The cuttings are made from young wood in a partly ripened condition. Experience has shown that cuttings made from side branches root equally as well, under this method of propagation, as leading shoots. The cuttings are planted in the sand and thoroughly watered, after which the close fitting glass sash is placed over the top of the frame and the muslin shade placed over the supports to prevent any direct sunlight from falling on the tops of the newly made cuttings. Air is not admitted into the frame until the cuttings have started rooting. Some varieties root in three weeks while others require two months.

All cuttings should be well rooted before heavy freezing occurs. The best treatment for cuttings rooted in outdoor frames, is to pot them up in October and place in a cool greenhouse or heated frame over Winter. There is always danger of heavy loss with conifer cuttings propagated in this manner if left in the frames over Winter.

Only a limited variety of cuttings give maximum returns when propagated in outdoor frames. The Biota forms roots readily under this method of treatment.

SUMMER CUTTINGS OF SHRUBS

Many trees and shrubs are readily propagated by taking soft wood or half-ripened wood cuttings like those of the herbaceous or soft-wooded plants in June and July. This furnishes a very cheap method of propagation. Some sorts root best from very soft cuttings, others only when the wood is quite mature. (See pages 180-224.)

Greenhouse rooted. The cuttings are best rooted in flats, in the greenhouse, where they may be easily handled, but they may also be placed in the bench. A house should be used which gets the sun. "Thoroughly renovate the benches and give a coating of whitewash which will sweeten the boards and destroy the disease spores. Four inches of sand will be necessary. Put a thin shading of lime on the glass and hang a piece of muslin inside the entire width and length of the bench. Tack the upper edge fast to the rafter, and arrange it so that the muslin will slide up and down upon a series of wires. The object of this is, that on dull days and in the early morning and late in the evening the curtain can be pulled up, admitting the light. The reason for putting the curtain on the inside is to allow the sun's rays to pass through the glass, thereby furnishing the necessary heat to cause root action, without allowing the direct sunlight to strike the cuttings, which would be fatal."* Such parts of the house as are used for cuttings should be screened with muslin hung from the sash bars. Because the work is done in hot weather, evaporation will take place rapidly from the cuttings, so that there must be as little circulation of air as possible.

As the cuttings are made, keep them moist by placing in damp paper. Insert in the sand, about two to two and one-half inches apart and one-half to three-quarters of an inch apart in the row. Firm the sand and thoroughly water, covering the cuttings with newspaper during the bright sunlight. Syringe the cuttings every morning, but only water them when they become dry. When the cuttings have rooted take off papers and continue to spray. A muslin shade will now be necessary. When well rooted, place in flats under a slat frame house out of doors and give plenty of water. Many kinds will make a foot of growth in the season. Protect for Winter in frames or if frames are not available, heel in somewhere until Spring, then set in open soil.

* Trillow, Wm. Propagation of Shrubs. Proc. of Soc. of Iowa Florists, 1912, pp. 75-80.

Frames. No bottom heat is necessary indoors, but in the frames some will be needed. A foot of fresh horse manure, well trodden, will furnish it. Over the manure spread a 4- to 6-inch layer of sand. Cover the frame with a tight-fitting sash and build a muslin canopy about 3 to 4 feet above it to protect the young stock from the sun.

Lilac cuttings should be made early in June as the wood ripens earlier than in some other sorts. By this same method may also be propagated such shrubs as *Andromeda, Hydrangea paniculata, Tamarix, Syringa, Forsythia, Robinia hispida, Akebia, Kerria, Symphoricarpos, Cornus, Clematis flammula, Berberis, Calycanthus, Viburum, Exochorda, Weigela, Deutzia, Lonicera, Ligustrum, Althaea, Sambucus and Lycium.*

LARGE STEM CONSERVATORY PLANTS

Alocasias, Dieffenbachias, Dracænas, *Colocasia odorata,* and some other conservatory plants are readily propagated by cutting the old stems into four-inch pieces, which are placed in the propagating bench with bottom heat but not too great moisture. Dust the pieces with powdered charcoal to prevent deacy. The Wardian case is useful for this purpose.

When rooted the cuttings are potted in sandy loam and peat. The canes will send up shoots from each eye but these shoots in Dracænas and Cordylines should be removed and placed back in the sand to make good roots. The canes of Dracænas are hard and will have to be sawed. The pieces may be split through the center; each section will make a new plant.

LEAF CUTTINGS

Plants with fleshy leaves or thick petioles may frequently be propagated by leaf cuttings. The Rex Begonia is the most familiar example illustrating this method. The leaves may be cut into a number of more or less triangular pieces (see fig. 24), each of which has a large piece of one of the main veins of the leaf. When such pieces are inserted half their depth into the sand, the veins will callus and the young plantlet start from this point. (See fig. 25.)

Another method of making a leaf cutting of the Begonia is to cut through the main veins at various points and pin the entire leaf upon the sand of the propagating bench (see fig. 26), so that the cut ends of veins are in contact with the sand. A confined atmosphere and slight bottom heat are beneficial to rooting. A bell jar, placed over the leaves, will provide proper conditions and prevent the leaf blade from drying out.

The Lorraine type of Begonias, including such varieties as Cincinnati, Melior and Mrs. J. A. Peterson should be propagated by leaf cuttings taken from plants with healthy leaves. Remove the flowers to throw the strength into the leaves. All blemished leaves should be discarded. Such plants, with very fleshy petioles and leaf blades, may be propagated by placing the petiole, or stem of the leaf in the sand. The blade is often reduced in area by cutting away the outer and thinner parts of the leaf. The usual temperature for rooting such cutting is 65 degrees to 70 degrees. The leaves of such plants as the Rose, Lilac, Cabbage, and Lemon, will root by this method, but this is not practiced commercially. Achimenes, Saintpaulia, Gesneria, Gloxinia, Streptocarpus, Hoya and Peperomia (see fig. 27), however, are successfully rooted.

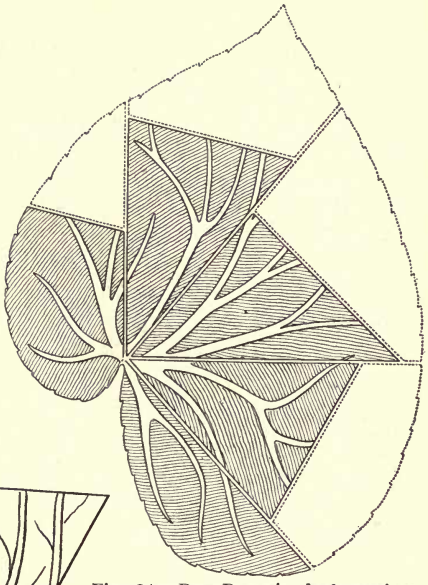


Fig. 24.—Rex Begonia leaf cutting The leaf is so cut that each portion has a piece of a large vein. Each section of the leaf when placed in the sand will root. The parts around the outside of the leaf are thin and are thrown away (shown by white in sketch)

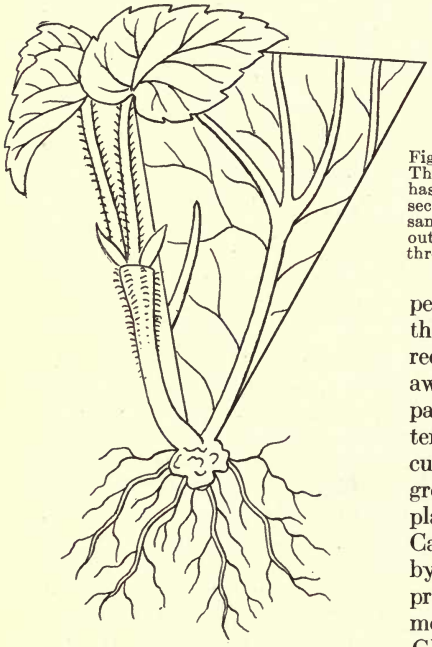


Fig. 25.—Rooted leaf cutting. The second cutting of the leaf shown in figure 24 has callused, rooted and produced a young plantlet

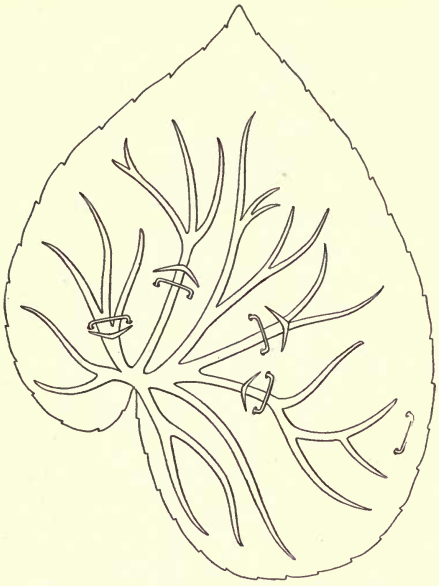


Fig. 26.—Another method of making a leaf cutting of Begonia Rex. The leaf shown in figure 24 might have been pinned to the sand by bent wires. Near the pins the main veins when cut would have produced small plants (See page 80)

In certain bulbous plants, as the Hyacinth, small bulbs are produced at the base of the leaves when they root.

Certain Cotyledons (Echeveria) which do not propagate rapidly enough by offsets may be grown from leaf cuttings set very shallow in sand and kept rather dry.

Sanseviera leaves are cut into three-inch lengths and allowed to dry for a day or two. They are then placed perpendicularly in the sand where if they are not overwatered they start new plants nicely. *Sanseviera zeylandica* var. *Laurenti* has green leaves variegated with white. It does not reproduce its white stripes from leaf cuttings and must be propagated by division.

Bryophyllum leaves when placed on the sand bench will send out young plantlets at every notch in the leaf.

Sphærogyne or Tococa, a beautiful broad-leaved conservatory plant, is increased by a peculiar method described thus by Geo. W. Oliver: "Its propagation is very simple but requires bottom heat. Cut the stems about two inches below the leaves, trim the leaves to within two inches of the petioles. Split the stem down the middle and place the cuttings in sand where there is a brisk bottom heat. Make sure that the under part of the small piece of leaf lies close to the sand, then every piece will root provided the leaves are neither too young nor too old. The rooted pieces should be placed in 2-inch pots. Replace the potted cuttings in the sand with the under part of the leaf again close to the sand. The young growth from the axil of the leaf will furnish the stem of the future plant. Too much water at any one time is apt to be hurtful.

"When the small pots are full of roots the rooted cuttings may be placed into 3-inch pots, without in any way removing any of the soil. This can easily be done if care be taken. All of the rooted cuttings will not make symmetrical plants and those which refuse to do as we wish can be brought under subjection by using them for propagation. The full grown plants do not look well when the leaves are irregularly developed, but the symmetrical plant is a thing of beauty. When old plants approach the flowering stage they should be cut down and used for propagation. They are seldom handsome when over four feet tall."

I. Bayley Balfour remarks that plants grown from a leaf taken near the flowering region of the Begonia, for example, will bloom more quickly than one obtained elsewhere.

ROOT CUTTINGS

Many plants with thick roots may be propagated by cutting the roots or root stocks into small pieces. But, curiously, variegations are often not reproduced by this method. Some are propagated indoors in the greenhouse, others, the stronger growing sorts, are propagated out of doors.

In propagating plants by means of root cuttings in the greenhouse, flats or shallow boxes filled with light loam and leafmold are used. There are three groups requiring somewhat different treatment.

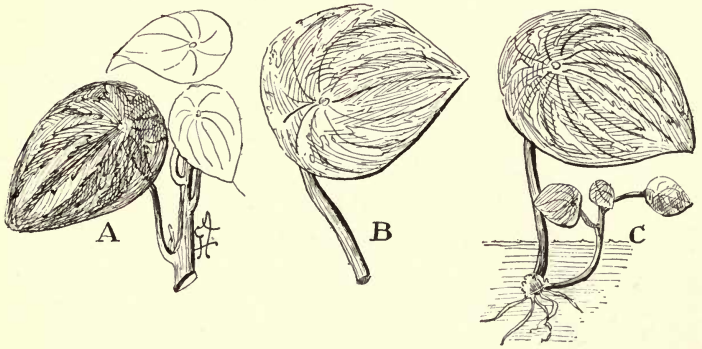


Fig. 27.—Leaf cuttings of Peperomia. A, A simple cutting of *Peperomia Sandersii*. B, A leaf properly cut prepared for making a leaf cutting. C, The growth from such a cutting as B. The young plantlet starts from a callus at the base of the leaf stem, or petiole (See page 81)

Section I. The smaller and more delicate rooted sorts are cut into lengths of one to two inches, and scattered over the surface of the soil, after which they are covered with about a half inch of finely sifted light loam or sand. Cover the flats with newspaper and start cool. Adventitious buds will soon form. When the growths have started a bit, the plantlets should be transplanted to other flats about two to three inches apart each way.

The following perennials are in this manner propagated:

Achillea Ptarmica (The Pearl)
Anchusa italica
Anemone japonica
Bouvardia Humboldtii. In Spring. Give bottom heat. Cover with sand, placing sphagnum on the sand until growth starts.
Campanula pyramidalis
Ceratostigma plumbaginoides (**Plumbago Larpentæ**)
Coronilla varia
Eryngium (perennial species)
Euphorbia corollata
Gaillardia (named varieties)
Phlox decussata. Cuttings may be taken in September or October and placed in a coldframe. These give good plants in May; saleable in Fall.
Phyllanthus
Polygonum
Romneya Coulteri
Salvia (perennial species)
Saponaria
Senecio pulcher
Stokesia cyanea
Verbascum (hybrids)

Section II. Some other plants, although propagated indoors, are best handled by placing the cuttings perpendicularly in the soil so that the upper end protrudes a half inch. This class of plants usually has fleshier roots than those in the previous group. The following are so propagated:

Fig. 28.—Root cutting of Horse Radish. Such 2-inch pieces of root make the best sort of cuttings.

Bocconia cordata
Dicentra spectabilis
Dodecatheon
Meadia
Gypsophila
Helianthus rigidus
Monarda

Pæonia. Use pieces 3 inches long, planting in beds out of doors in Fall; especially successful with varieties of *P. officinalis.*

Papaver. Fleshy root species. Cecil Davies in *The Gardener's and Florists' Annual for 1917*, writes, "Between August and December is a good time to start the named varieties of Oriental Poppies. Obtain strong field-grown plants, cut the roots into lengths of 2 or 3 inches, pot into 3-inch pots and place in coldframe for the Winter. Nice plants result by May."

Statice
Thermopsis

Section III. Root cuttings when planted in the open ground are usually large in diameter and four to six inches long. They are planted almost horizontally in trenches and covered two inches deep. Some of the shrubs so propagated are:*

Æsculus parviflora
Amalanchier
Aralia
Blackberry
Calycanthus
Campsis
Caragana
Ceanothus
Cladrastis
Clerodendron
Cydonia
Dewberry
Dimorphanthus
Halesia
Hypericum
Kœlreuteria
Lagerstrœmia
Paliurus
Paulownia
Phellodendron
Prunus
Rhus
Robinia
Rosa
Rubus
Sambucus
Sassafras
Staphylea
Stephanandra
Syringa
Wistaria
Xanthoceras
Xanthorrhiza
Xanthoxylum
Yucca

* More definite information about some of these shrubs is found on pages 180 to 224

CHAPTER III

BULBS · LAYERS · DIVISIONS

BULBS — HYACINTHS — Harvesting — NARCISSUS AND TULIP — BULBLETS — CORMS — TUBERS AND TUBEROUS ROOTS — DAHLIAS — FANCY LEAF CALADIUM — OFFSETS — SUCKERS — LAYERS — Simple—Preparing Plants for Layering—Tip—Serpentine—Continuous — Air — Chinese — Mound — RUNNERS — RHIZOMES — CONSERVATORY PLANTS — DIVISION OF PERENNIALS.

BULBS are actually entire blooming plants with the stem, leaves, and flower telescoped together. Under proper environmental conditions they start to grow and bloom. There are two types of bulbs: the tunicated and the scaly. The tunicated bulbs, illustrated by the Onion and Tulip, are clothed in a tight-fitting dry skin or tunic (See fig. 36). The scaly bulbs, illustrated by those of the Lily (see fig. 30), are composed of thick, overlapping scales.

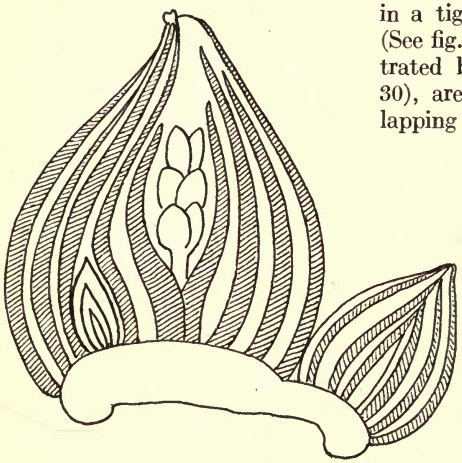


Fig. 29.—Diagram of bulb structure. Note the thick fleshy scales which compose the main part of the bulb; the flower stem and true leaves at the center of the bulb; the two small bulbs, or bulbels, produced between the scales but gradually pushed outside as the bulb grows; the white area at the base of the bulb corresponds to the stems of plant parts above the soil

Many bulbs propagate naturally by the production of small bulbs, or bulbels within them, in which case the small bulbs gradually become larger and larger until they are of blooming size. (See figs. 29 and 32.) The behavior of the Narcissus in producing double-nose bulbs will illustrate this. When bulbs propagate by this method, frequent transplanting is necessary to keep the old and new bulbs from crowding. A number of our bulbs in the garden are multi-

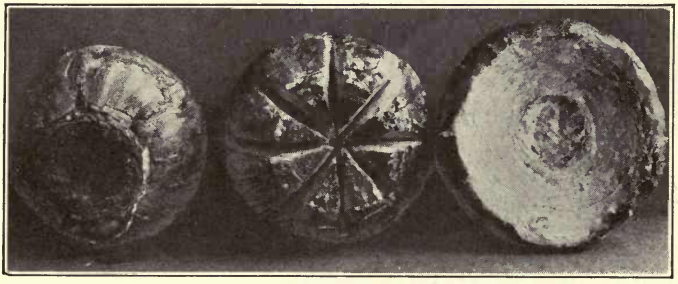
plied by taking the bulbels and starting them in sandy soil in small pots or boxes. Notably are *Begonia Evansiana* (the Hardy Begonia), *Oxalis*, Tuberose, and many of the Dutch bulbs. Many of our Spring flowering bulbs are grown and propagated in Holland. For list of bulbs and details of their propagation see page 179.

Fig. 30.—Easter Lily bulb. This illustrates the scaly type of bulb (See page 86)

HYACINTH PROPAGATION

The propagation of Hyacinths is about as interesting as that of any bulb. The Dutch have two commercial methods, known as "notching" and "scooping." In notching (see fig. 31, B), cuts are made transversely in wheel or star fashion across the base of the bulb. Just how far to cut is learned by experience. If the cut is made too deep the young bulbs will not start, and if not deep enough too little increase is obtained.

By the second method, that of scooping, the base or stem of the bulb is cut out, leaving the bottom scooped so that each layer of bulb scales is cut through. (See fig. 31, C.)



A B C

Fig. 31.—Hyacinth bulbs. A, Base of a bulb. B, The base of the bulb notched for propagation. C, A bulb scooped

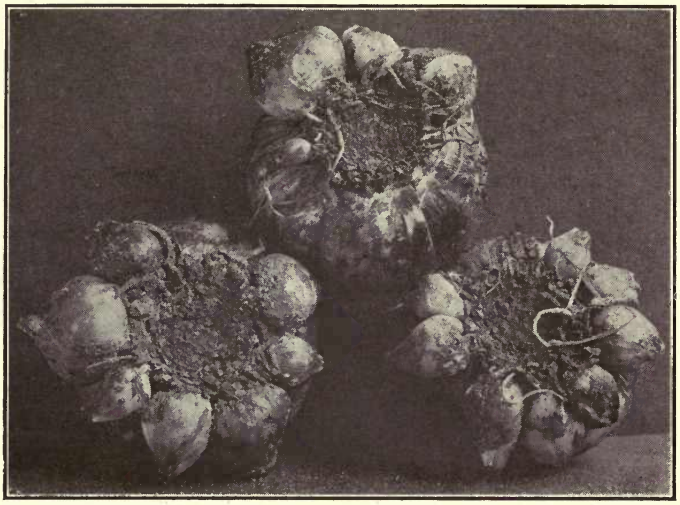


Fig. 32.—Hyacinth bulbs. This cut shows the natural method of producing bulbels at the base of the bulbs

Each method has drawbacks. The notched method results in few bulbs (see figs. 33 and 34) of a large size in a short time; by scooping (see fig. 35) three times as many bulbs are produced, but they are tiny and of inferior vitality. Offspring of notched bulbs flower in three to four years, scooped bulbs require at least four or five.

Fig. 33.—The first stage of a notched bulb

PLANTING AND CULTURE OF HYACINTHS

Fred de Meulder, of Lisse, Holland, in *The Florists' Exchange* for April 17, 1915, gives the following notes on the propagation of these sorts in his native land:

"Both classes of bulbs undergo practically the same treatment in the 'nurse-room,' a place in the bulb store reserved for them and kept at a high temperature. Here they remain for a fortnight or so—when about one hundred bulbels in the case of scooped bulbs, and thirty in that of the notched ones will have formed upon them. They are left until all the other bulbs are planted so as to give them the care of the nursery as long as possible. Then, usually in the last week in October or the first week in November, they, too, are taken to the fields and planted. The ground has been carefully prepared for their reception—well dug up and liberally dressed with well-rotted cow-dung earlier in the year. This kind of fertilizer is preferred to others, including lime, etc., both because it is more economical and because it is less harmful to the Hyacinth, whose extremely sensitive bulb would be burned up by lime or similar substances Hyacinths cannot be set in the same ground except at two-year intervals, or at one-year intervals if the soil has been turned up from a much greater depth. Both Tulips and Hyacinths thrive on a piece of ground that is used in alternate years for each of them, and this is what is usually done.

Fig. 34—A notched Hyacinth bulb. The bulbels are few but larger than those obtained when bulbs are scooped (See page 87)

"Taken to the field, the bulbs are set in the ground at a depth of about five inches, an area of about five square inches being allowed for each. The flower beds, one of which stretches almost the entire length of the field, are so disposed that each shall be three feet wide and that a path one foor wide shall be left between them. When all is ready the whole field is covered with about ten inches of hay or straw, a necessary precaution, for the Hyacinth is very susceptible to the cold. The fields lie thus till Spring, and then

under the influence of the sun and rain the leaves, and later flowers, appear.

"Generally the first Sunday in April, if the weather has been fine, or the second if it has not, finds the fields in bloom. Then it would be hard to find a more beautiful place on earth than the thirty-mile stretch from Haarlem to Leiden. The natives are not less appreciative of the attraction than the stranger. On this Sunday the highway from Hillegom to Leiden is one mass of people on foot, on bicycles, in motors, carriages and trams. The great concern of the people to see the annual flower show is better understood when we know that this one day is probably the only chance they have to visit it. The flowers are not more attractive to the people than to the grower, but the latter's love of beauty must yield to his business interests, so the flowers are cut off to allow the additional nourishment thus gained to go to the bulb. The clipping usually takes place ten days after the flowers appear.

Fig. 35.—A scooped Hyacinth bulb. Compare the great number of small bulbels produced by this method with those produced by notching (See page 87)

"The bulbs now begin to enlarge and are left to grow during April and May. About the middle of May, with fair warm weather, the leaves turn yellow, a sign that the bulb is matured and can be taken out. Wet, cold, weather at this time of the year retards the ripening process, forcing the harvest into June.

"In the event of a protracted spell of wet and cold, some method of hastening the bulbs to maturity must be resorted to. One recently adopted is to remove the bulbs from the ground before they have reached the proper stage and keep them in a warehouse at the temperature of fine Summer weather. Forced in this manner they mature at the proper time and make it possible to meet the demands of those

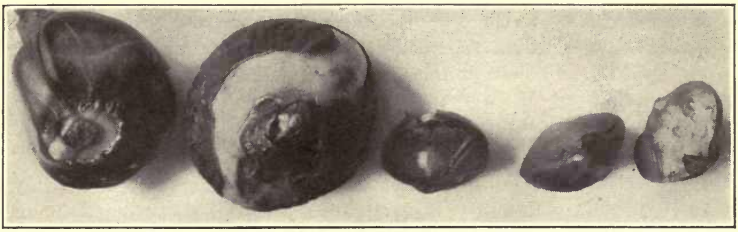


Fig. 36.—Tulip propagation. It is the natural method of propagation for tulips to send out bulbels at their base (See page 86)

customers who want flowers in bloom at Christmas. Only with Hyacinths was this procedure found impracticable; but with Tulips it gave indifferent results.

"*Harvesting.* When the bulbs are taken up from the ground the new bulbels are found to have grown to the size of acorns; the mother bulb has almost entirely disappeared, having served as food for her numerous progeny. These are now taken to the warehouses and placed on laths to dry. This is merely a matter of providing plenty of air and the ordinary Summer temperature. This is also the case with the old bulbs of the 'notched' class. The opinion prevalent in some quarters that it is necessary to apply absorbent material to all the bulbs after treatment, experience has shown to be without foundation. Only in the case of 'scooped' bulbs have we found the application of an absorbent at all necessary.

"The cleaning of the bulbels, a process always attended with a good deal of danger of damaging them, is deferred till the Fall, when any injury the tender plants might sustain will be speedily healed by the earth wherein they are placed

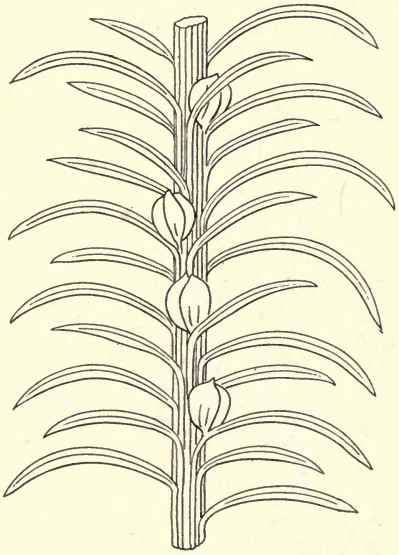


Fig. 37.—Bulblets. The sketch shows a Lily stem upon which small bulbs, or bulblets, are produced (See page 92)

soon after. Set in the ground again in October, the new bulbs bear leaves in the following Spring. The second year those of the 'notched' class flower, while the others require still another season of growth."

NARCISSUS AND TULIP PROPAGATION

Narcissus and Tulip propagation must in general be left entirely to Nature (see fig. 36); no cutting of the bulbs can be done to increase the production. Left to themselves each bulb produces three or four bulbels, of which two or three develop to good size, the old bulb disappearing. The following Autumn the young bulbs are taken up, cleaned, and replanted. It thus takes two years to get Narcissus and Tulip bulbs.

BULBLETS

Certain bulbous plants, as the *Lilium tigrinum*, *Dentaria bulbifera*, certain ferns, *Ranunculus Ficaria*, and the Multiplier or Potato Onion, produce small bulbs in the axils of their leaves above ground. These are bulblets. (See fig. 37.) They can be planted immediately after ripening and will multiply the particular plant true to variety. *L. candidum* can be forced to produce bulblets. (See p. 155)

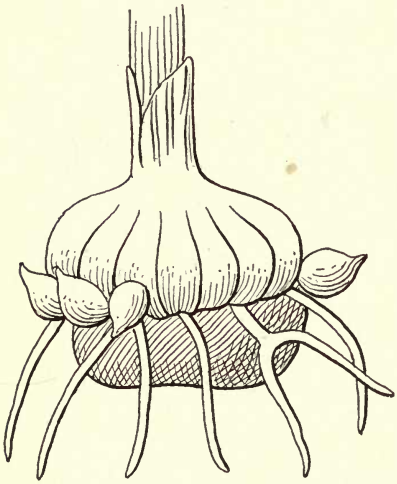


Fig. 38.—Gladiolus corm. The sketch shows the method of producing new corms above the old one. Between the two corms small corms, cormels or spawn, are produced (See page 93)

CORMS

Corms are much shortened rhizomes or thickened bases of stems, usually subterranean, in which food is stored. A corm differs from a bulb in that the greater part of a bulb is not stem, but scales, which are really thickened bases of leaves, the stem being merely a much-flattened plate from which root and bulb scales arise. Corms also are covered with shells or scales, but these are scarious or dried, and are called husks or tunics. These scales are likewise the bases of leaves, but they are not thickened as in bulbs. Botanically considered, a bud or the potentiality for a

bud exists in the axils of all leaves. There should be one bud for each layer of tunics or husks. Because of the manner of growth of the Gladiolus, a cormous plant, which is in one plane, these buds should have an opposite arrangement (see fig. 39), thus causing them to lie in one straight line through the center of the corm.

With the Gladiolus, it takes from one to four years, according to the variety, for a seedling to produce a corm of blooming size.

Every stem that makes vigorous growth has at its base a corm. Each corm has several buds, of which each one that grows will produce a new corm on top of the one planted. The development of seven Gladiolus corms of blooming size in one season has been reported. In this way a grower's stock is not only reproduced each season, but also rapidly increased, provided good soil and proper cultivation are given.

The vigor and the thickness of a corm depend much on the proper maturing of the foliage. If, in cutting the spike, little vegetative growth is left above the soil, only small quantities of food can be manufactured by these abbreviated leaves, and the base of the stem, or corm, in which the food is stored, suffers. The failure to carry over stock is often due to cutting the flower stems near the surface of the soil, the corms thus being able to make little or no development. The suggestion, then, is that if one wants an annual renewal of corms, care must be exercised to leave sufficient foliage after cutting the spike.

It is the general opinion that corms which have been allowed to bloom every year for three or four years become thinner and thinner.

Soon after the base of the growing stem of the Gladiolus has begun to thicken, small corms are found to have formed between the old and the new corm. These are properly called cormels. (See fig. 38.) They are covered with a hard shell, thus differing from seedling Gladioli of the same size. which have a covering more like a husk, composed of the dried bases of the previous season's leaves.

Cormels should be stored in soil so that they will not dry out

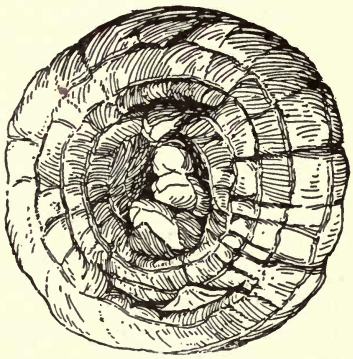


Fig. 39.—Gladiolus corm from which the tunic has been removed. Note the scars left by the bases of the old leaves. The buds are in a straight line, and there is one bud for each ring on the corm. Sketch taken from Cornell Extension Bulletin No. 10

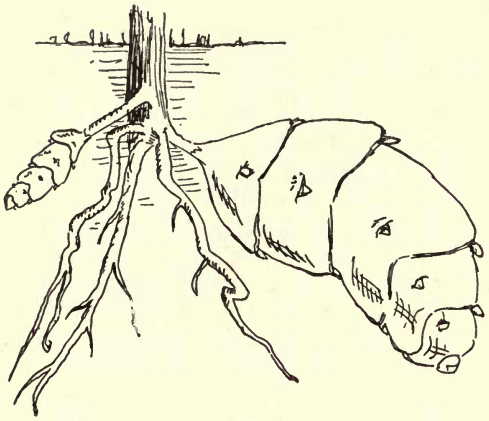


Fig. 40.—Tuber of Jerusalem Artichoke. Note that the eyes, unlike those of the Dahlia, are on the tuber

badly. When it is time to sow them they should be soaked for several days to soften their hard shells. Some growers peel them but if they have been stored in damp soil this is not necessary. Sow them as one would sow seed. Some of the larger ones will bloom the first year. A more rapid method of multiplying new varieties is to cut the corm into several pieces so that each piece has one or more eyes.

Other plants that produce corms are Crocus, Cyclamen, Antholyza, Colchicum, Arum, Arisæma, Ixia, Montbretia, Moræa, Sparaxis, Tigridia, Watsonia. (For additional list see page 179.)

TUBERS AND TUBEROUS ROOTS

Certain plants develop thickened portions of their stems, called tubers, beneath the soil. Tuberous roots differ from tubers in that they have no eyes from which growth may start. The eyes of the tuberous roots are at the base of the old flowering stem. Examples of tubers are: Potato, Jerusalem Artichoke (*Helianthus tuberosus*), (see fig. 40), *Begonia Evansiana*. Tuberous roots are found in the following plants: Dahlia (see fig. 41), Tuberous Begonia, Boussingaultia, Cal-

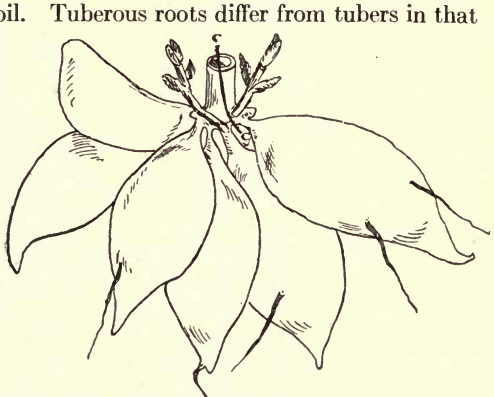


Fig. 41.—Tuberous roots of Dahlia. Note that the sprouts start at the base of the old stem and not on the tuber itself. The line marked C-C shows how the Dahlia should be divided, each new plant having a piece of the parent stem, a tuber and a sprout

adium, *Hemerocallis Dumortieri* and Poison Hemlock. These often have the ability to produce eyes.

PROPAGATION OF DAHLIAS

The tuberous roots should be started about April 1st in a warm, light room, being placed in a shallow box of sand or light soil. When the young shoots begin to show, the tuberous roots should be cut

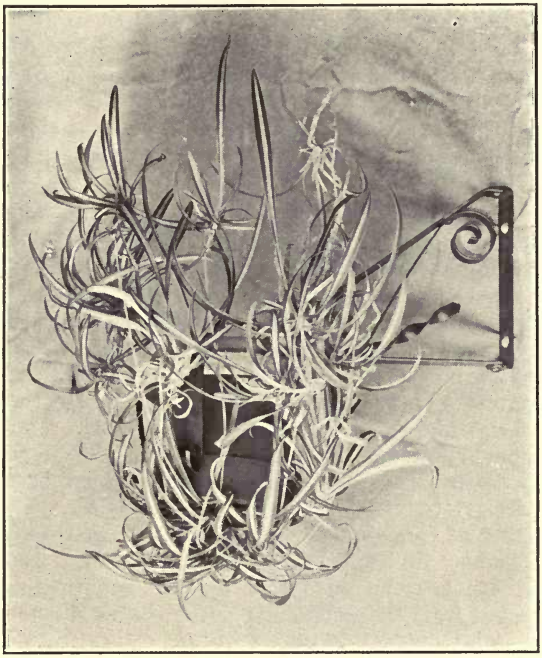


Fig. 42.—Offsets of Anthericum. Note how these plantlets are produced upon pendulous stems. (From Milady's House Plants) (See page 96)

apart so that one or two eyes are allowed to remain on each piece; the eyes start from the collar between the old stem and tuber. (See figs. 19 and 41.) Dahlias are also propagated by cuttings.

PROPAGATION OF FANCY LEAF CALADIUMS

Small tubers started in February will be large by September, when they should be removed from the soil and stored in sand. When to be propagated they should be cut into good sized pieces

and covered with powdered charcoal. They are then placed on a bench in sphagnum and sand where they can root nicely, before being potted in a mixture of loam and leafmold. This treatment applies also to Gloxinias and Tuberous-rooted Begonias which, however, are not cut to pieces.

OFFSETS

Certain plants produce small plantlets, rosettes from the parent plant which, if allowed to strike the soil, will root readily. These are often designated as offsets. Familiar examples of offsets are those found in Cotyledon (the Hen-and-Chickens), Anthericum (see fig. 42), Marica, Œnothera and Boltonia. The usual method of propagating these plants is to place the offsets in sand for several weeks to produce a good root system before potting.

SUCKERS

Suckers are unexpected shoots from the base of a plant. The formation is frequently encouraged by injury to the roots. Familiar examples of trees which sucker are: Sassafras, Asimina, many of the fruits, Ailanthus and others. When the roots are not injured there is little trouble with suckers. Some propagators hold that new plants grown from suckers are later inclined to sucker.

The fruiting of the Pineapple, (*Ananas*) is followed by the production of suckers which are removed and rooted in sand. The Banana is propagated almost entirely by suckers.

Plants which sucker are easily propagated by root cuttings. (See page 83.)

A number of conservatory plants, such as Agave, Caladium, Amorphophallus, Billbergia, Tillandsia, Guzmania, Anthurium, Pandanus, Vriesia and Carludovica, are readily propagated from suckers broken from the plants and potted in small pots plunged in a propagating case. (See page 66.)

LAYERS

Propagation by layers consists in rooting a portion of the plant without detaching it from the parent plant. Some plants may be propagated by this method when cuttings fail. Many propagate themselves naturally by this method, the branches that come in contact with the earth throwing out roots. Creeping Jenny, Grapes, Sedums, Tomatoes, and many other plants take root at the nodes, or eyes, very readily. Plants that do not layer easily are also difficult to root from cuttings.

Simple layers. In the case of many plants roots will easily form when a branch is bent down and covered with earth. This is *simple* layerage. It is advantageous to peg the branches in some manner and to cut the stem partially through near an eye (see fig. 43) at the point where roots are desired. Sometimes, instead of notching the stem, the propagator breaks it slightly or binds a wire tightly around it. The leaves are then removed from the portion of the plant that is buried. Some of the trailing evergreens are propagated by layers, especially Junipers and Yew.

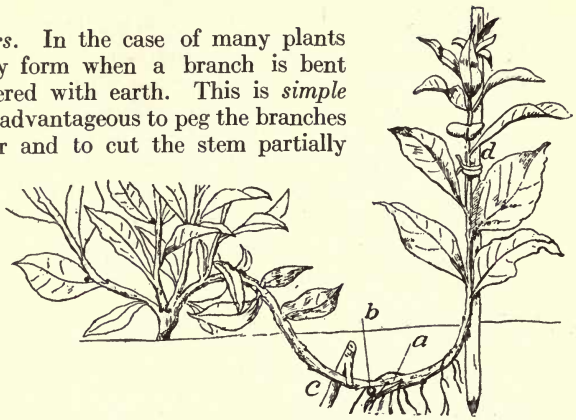


Fig. 43.—Simple layering. Note how the branch is bent down; a slit has been cut in the stem at *a* and held open by a pebble, *b*; a peg, *c*, holds the layered branch firmly in the soil; and the stake, *d*, keeps it upright. Note how the roots have formed

PREPARING PLANTS FOR LAYERING

Early Spring is the time to prepare for layering. Stock to be layered should be growing with ample room between the plants, to permit of the shoots being layered all around them, and still leave room for cultivating between them. The soil should be con-

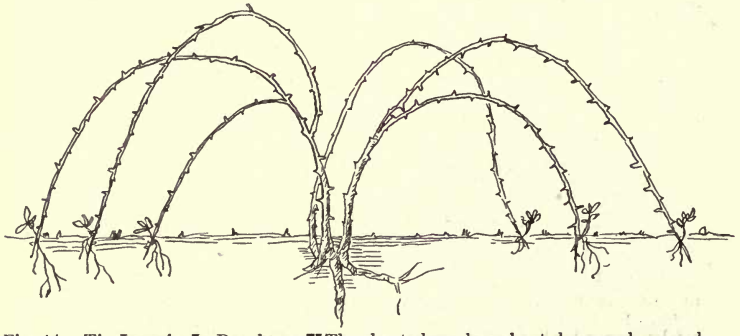


Fig. 44.—Tip Layering a Raspberry. The shoots have been bent down and covered with soil; each one has rooted and produced a young plantlet, which may be severed and grown separately

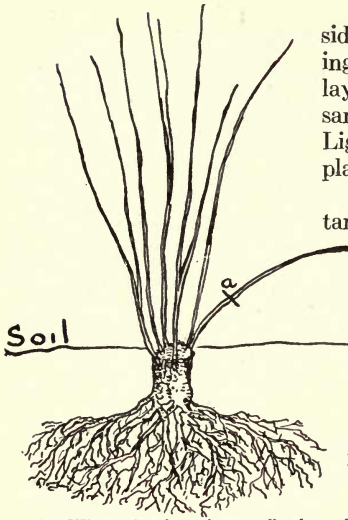


Fig. 45.
Layering Hydrangeas

(*a*) Where the shoot is cut off when the young plants are taken up.
(*b*) Shows the point where the piece of shoot is cut off to make the young plants ready for planting.
(*c*) Willow branch holding layered branch in the soil.

sidered: it should be rather light, making work easy for the operators; the layers, too, root more freely in light, sandy soil than in any other kind. Light soil, heavily enriched, may be placed around the plants.

Having the plants at a proper distance apart, and the soil prepared, the next thing is to prune the plants, to cause them to make some young, strong shoots for layering. These shoots should, preferably, be of the same season's growth, though older ones will root. If not already pruned, do it before growth starts, cutting the

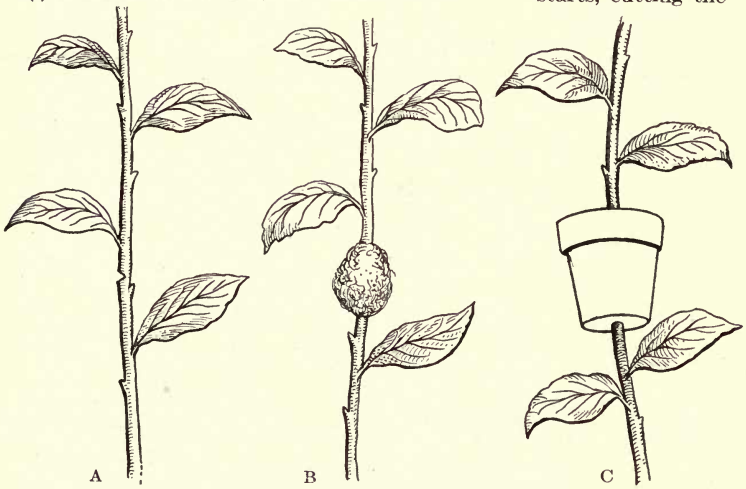


Fig. 46.—Air layers. A, A branch notched preparatory to air layerage. B, A Chinese layer, the notch has been covered with a ball of moist sphagnum moss. C, A pot layer; a pot filled with moss or sand has been used instead of just a ball of moss

(See page 97)

plants down severely. Bear in mind that the anticipated shoots must be layered under the surface, so the nearer they are to the ground the better. Layering should commence as soon as the shoots are of sufficient length to permit of it.

Tip layers. Black Raspberries root easily when the tips of their branches are buried. It is best to prune the long shoots early in the Spring to cause them to branch, thereby obtaining more new plants. (See fig. 44.) This method is known as *tip layering.* After the layers (obtained by any method) have rooted they are severed from the parent plants.

Serpentine layers. When the branch of a plant is covered with soil at a number of points, the term *serpentine,* or *compound* layering, is applied. It is used very advantageously with vines.

Continuous layers. When nearly the whole branch is covered, the process is called *continuous layerage.* This method is confined to a few shrubs and vines which grow readily from buds even though they are covered with earth.

Air and Chinese layers. With other plants whose branches cannot be bent down to the earth, some method of *air* or *pot layerage* is used. Ordinary flower pots are split in two pieces (see fig. 46, C) and placed around a branch. The pot is tied together, an incision is made in the stem and the pot filled with sphagnum moss or soil. It is well to place a match in the cut to keep it open. This method is successfully used on Rubber Plants, Dieffenbachia, Ardisia, Camellia, Dracæna and Crotons when they become too tall and lose their lower leaves. The pot is not necessary; many plants are layered by merely tying a ball of sphagnum moss around the stem which, as before, is injured. Such layers are called *Chinese layers.* (See fig. 46, A and B.) So soon as roots form, the new upper plant is removed and potted.

Mound layers. Plants with rather stiff branches which can hardly be bent down and covered with soil are *mound lay-*

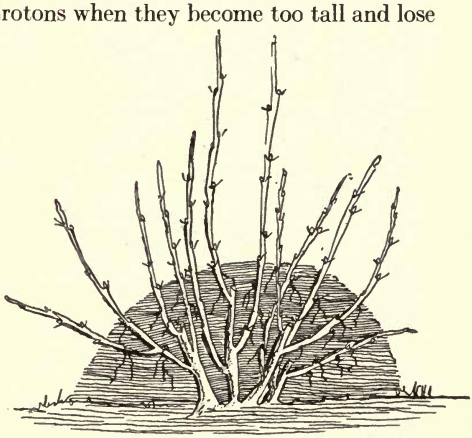


Fig. 47.—Mound layer of Gooseberry. Note that the shoots have been cut back close to the soil previous to mounding the soil about the plants; each shoot is rooting nicely.

ered. In this method the plants are cut back very severely to cause the production of a great number of branches. The bases of these are covered with soil and soon develop roots. (See fig. 47). When the process is completed, the plants are divided. Gooseberries, Spiræa Anthony Waterer, Hydrangeas, Quinces and many other shrubs are propagated by this method.

RUNNERS

Certain plants, such as the Strawberry (see fig. 48) and Nephrolepsis, produce *runners* or little plantlets, upon specialized branches. These are readily made into new plants by separating them from the parent plant and potting into 2- or 2½-inch pots. In the Strawberry patch there is frequently a succession of these new plants started, but for the best results the first runners to be produced from the plants should be trained to root in pots sunk into the soil.

Fig. 48.—Strawberry runners

RHIZOMES

A rhizome, unlike a root, is an underground stem. In other words, rhizomes bear roots but also have prominent leaf buds or eyes. (See figs. 49 and 50.) Rhizomes are also known as root stocks.

Divisions of a root stock or rhizome are safely planted vertically when it is known which is the upper end, otherwise, most divisions should be placed in the soil horizontally.

Many of out outdoor plants which bear rhizomes are best propagated by taking pieces which bear one or two eyes. For examples see under Bulbous Plants and Their Propagation, page 179.

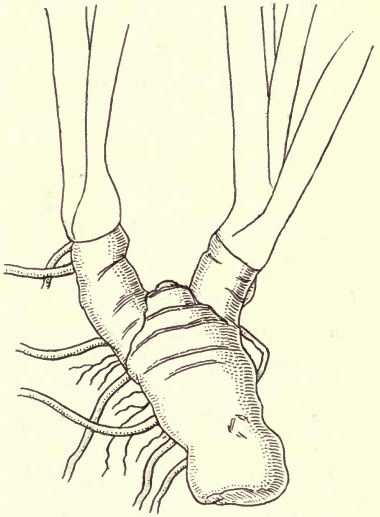


Fig. 49.—Portion of German Iris Rhizome. Between the leaf shoots is shown the scar left by the flowering stem. Each shoot might be separated as an independent plant

CONSERVATORY PLANTS

Many conservatory plants are propagated by divisions of a rhizome. Some examples are:

Acanthus. Divide in Spring or early Autumn.

Aglaonema. The short rhizomes when divided are placed in sand to root.

Alocasia. Usually in March. Keep close, moist and warm. Use Wardian case.

Anthurium. Place divisions in peat, sphagnum moss and sand, in small pots plunged in Wardian case, at temperature of 75° to 80° with bottom heat. Propagated in Midwinter.

Arum. Division of rhizome in Spring.

Aspidistra. Wash out old soil before growth starts and divide up rhizomes in small pieces; place in propagating bench of sand to root, 80°, then pot. If fewer and larger plants are wanted merely divide old specimens.

Caladium. 1. Many sorts produce small offset tubers; 2. or cut out the eyes on large tubers taking a generous piece of the tuber.

Calathea. (See Aspidistra.)

Calla. (Not Richardia.) (See Anthurium.)

Canna. The rhizomes are rather tuberous. In March divide, place in bench or in flats until rooted, then pot.

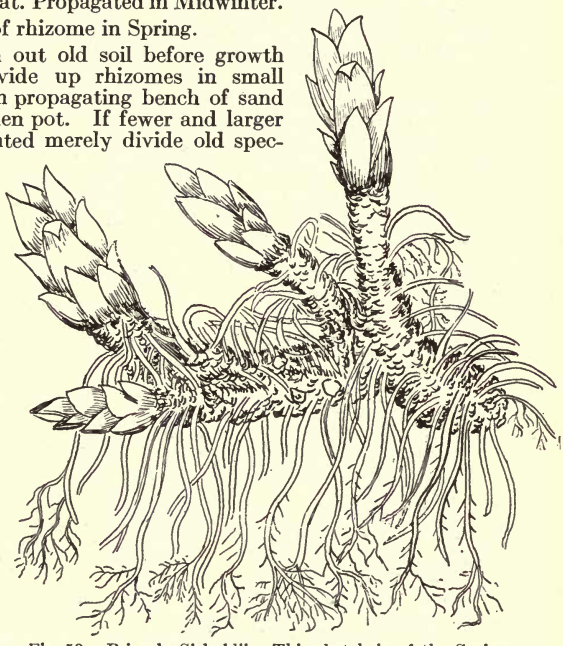


Fig. 50.—Primula Sieboldii. This sketch is of the Spring stage showing the rhizome

Colocasia. (For *Colocasia odorata* see Caladium, above.)

Convallaria. (See Lily of the Valley.)

Fatsia papyrifera. Best in Spring.

Ferns. (See page 146.)

Lily of the Valley. (These rhizomes are called pips.) Divide. Grow in sand with good bottom heat and shade.

Maranta. (See Aspidistra.) (See fig. 51.) Never below 65°.

Monstera. Each piece should have several joints.

Nelumbium. Aquatic. Cut up rhizome and anchor to soil with a stone.

Nymphæa. Aquatic. (See Nelumbium.)

Zantedeschia (Richardia.) (Calla Lily.) Dry off plants in Summer. Pot in early Fall, removing offshoots which, when potted several together in a pot, often bloom the first or second year.

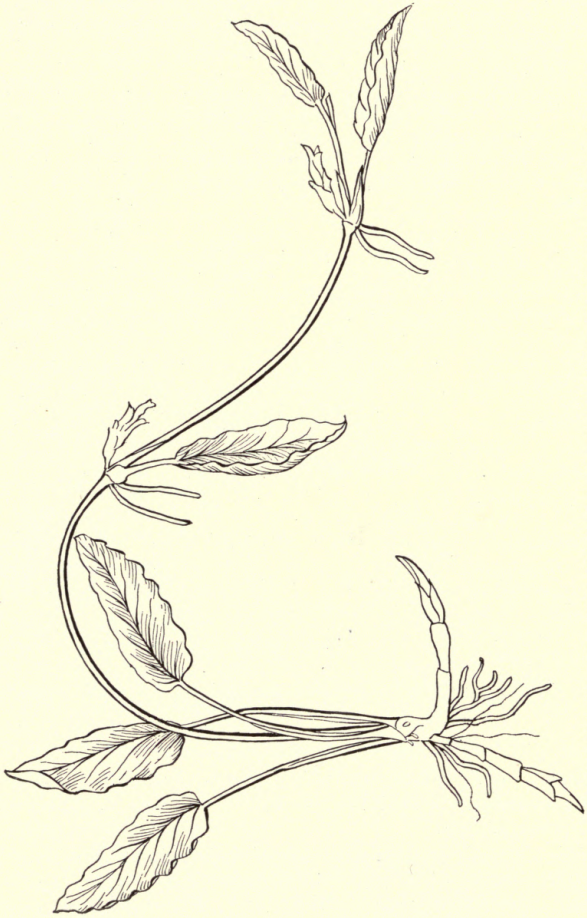


Fig. 51.—Maranta. Note the rhizomes at the root and the runners above the soil

DIVISION OF PERENNIALS

One of the simplest methods of propagating perennials is that of division. With a large knife or spade huge clumps are cut into convenient sizes for replanting. Certain very rampant growers get very much choked after growing in one place for any length of time. Examples of perennials which require almost annual propagation are: Michælmas Daisy, *Achillea ptarmica* and *A. Millefolium roseum* Helianthus, Sedum, some Veronicas, Chrysanthemums, Œnothera, and all perennials which sucker badly should be moved and divided every year. Artemisia, Boltonia, Campanula, Geum, Funkia, Doronicum, Armeria and Thalictrum are all propagated by division.

Certain perennials, such as Peonies, Dictamnus, and Fritillaria, should not be moved often; they must be thoroughly established in order to bloom properly. Peonies should be moved every six or seven years, Phlox every four years and Iris every three years.

Boxwood can easily be separated by tearing to pieces old dwarf plants; the divisions may be replanted to make a tiny hedge.

CHAPTER IV

GRAFTAGE

Terms Defined — Objects — Results — Limits — So-called Graft Hybrids — Characteristics of a Stock — Selection of Wood for Cions — Time to Graft — Important Points — Whip Grafting — Root — Cleft — Veneer — Side — Splice — Saddle Graft — Bridge — Crown — Terminal Bud — Budding — Time to Bud — Shield Budding — Patch — H Budding — Inarching — Seedling Inarch — Wax—Top Grafting—Applying Wax—Cactus Grafting—Grafting Conifers.

TERMS DEFINED

THE term *graftage* is now accepted to include both grafting and budding. The real difference between these two processes is slight. Budding is inserting a single bud into the growing wood of a plant; grafting consists of using a twig bearing several buds instead of a single bud. Also included under graftage is the process of inarching, or grafting by approach.

The term *cion* (often spelled *scion*) is used to designate the portion of one plant which is inserted upon another plant, called the *stock*. The stock is usually rooted so that it may gather the nourishment from the soil and furnish it to the cion.

It must be remembered that even though the stock and cion are in intimate union, each retains its own individuality. The bark and wood tissues of the two never mix, but merely knit together.

Most dicotyledonous plants, as Apples, Legumes, Cacti, Composites, Crucifers and members of the Potato family, have been grafted. Monocotyledonous plants, as Lilies, orchids, Grasses, Irises, and the Aroids, have never been grafted for commercial purposes, because their parts are not adapted for the essential close union. Evergreens are also grafted.

OBJECTS OF GRAFTING

The reasons for grafting plants are well set forth by Baltet* as follows: "The object of grafting is—

1. To change the character of a plant, by modifying the wood, the foliage or the fruit which it was required to produce.

2. To excite the development of branches, flowers, or fruit on the parts of a tree where they are deficient.

3. To restore a defective or exhausted tree by transfusion of the fresh sap of a vigorous kind.

4. To bring together on the same stem the two sexes of monœcious† plants, in order to facilitate their reproduction.

5. To preserve and propagate a great number of woody or herbaceous plants for use or ornament, which could not be reproduced by any other means of multiplication."

THE RESULTS OF GRAFTING

After the cion grows it produces its leaf, flower, or "fruit after its kind." Shoots from below the point of union continue to produce their own characteristic leaves, flowers and fruits. Grafting hardly ever materially changes the qualities of the characteristic stock and cion.

Dr. L. H. Bailey‡ has summarized several effects of grafting which are of interest.

1. *Dwarfing.* Grafting may alter the stature of a plant. It is a common method of dwarfing plants. The pear is dwarfed by grafting on Quince; the Apple by working on the Paradise Apple stock.

2. *Adapting varieties to adverse soil.* Some varieties of Plums are worked on the Peach. which causes them to thrive in a sandy soil. Roses when grafted on Manetti stock tolerate more sandy soils.

3. *Adapting plants to adverse climate.* The stock may mature sooner and cause a relatively earlier maturity of the cion, or it may actually impede the flow of sap and thus cause earlier ripening. The Oldenburg and other Russian Apples are used as stocks, because maturing early they cause the complete ripening of the wood of the

* Baltet, Charles. The Art of Grafting and Budding, p. 2.

† It would seem that Baltet might have included *diœcious* as well as *monœcious*. Monœcious plants have flowers bearing only one sex, but both kinds of flowers, on one plant; diœcious plants have the separate sexes on different plants. This object also includes the grafting of pollinizers upon self-sterile varieties.

‡ From *Garden and Forest*, Feb. 26, 1890. The above excerpt from this paper is much changed, but the main facts are found in the article cited.

cion, which consequently is less injured by adverse Winter conditions. Similarly, the Peach does better on Plum in cold soils.

4. *Correcting poor habit.* Canada Red Apples, which are notably poorly shaped trees, are improved by top working (see page 132) upon some good grower.

5. *Provides rapid method of testing seedlings.* Grafting often hastens fruiting and flowering. Seedlings which require a long time to attain the age for flowering or fruiting are frequently budded or grafted upon a mature tree. (See Inarching, p. 125.) This method saves years of waiting for, perhaps, an inferior fruit. With the Pear it often takes eight to ten years before a seedling will bear fruit; but by budding, Pears may be produced in two years. Even the bud from a seedling, therefore, becomes a part of the tree and the vigorous growth of its first year may be expected to produce flower and fruit buds. Furthermore, it is known that cions from young trees bear fruit more readily when inserted in old trees, than when set in young ones. In France this system, by which a great number of excellent Pear varieties has been introduced, has been commonly practiced. There is keen pleasure in hybridizing fruits, raising the seedlings and awaiting the results of the labor.

6. *Modifying season of ripening of fruit.* Grafting will often alter the fruit ripening season by causing a difference in the time of maturity of wood of stock and cion. Pears of the variety Winter Nelis keep better when grafted on Bloodgood stock than when grown on Flemish Beauty. Twenty Ounce Apples ripen earlier than normally when grafted on Early Harvest.

7. *Increasing fruitfulness.* The increase in fruitfulness of some varieties may be due to better adaptation to climatic and soil conditions. Many instances of increase in fruitfulness, by grafting, can be given. A less vigorous stock, by checking excess growth, often causes fruitfulness.

8. *Delaying the running out of varieties.* Grafting, rather than growing plants from cuttings, seems to delay the degeneration of varieties of certain Camellias and Roses.

9. *Increasing size of fruit.* Certain Pears when grown on the Quince are much increased in size. This is analogous to the effects of ringing a branch, the food manufactured by the leaves is kept in the branches instead of going to the roots.

10. *Modifying color.* Grafting causes a change in the color of flower, foliage and fruit, but many cases of apparent difference are due to environmental influences rather than grafting. *Prunus Pissardii* shows a deeper colored foliage, when grafted on *P. amer-*

icana, than when worked on *P. domestica*. Earlier maturing also results in better color.

11. *Influencing flavor of fruit.* Grafting may appreciably influence flavor. Angoulême Pears are improved in flavor when worked upon the Quince. Grafted grapes are larger, fewer, and contain more sugar and more acid.

12. *Influence upon root system.* The nurseryman can tell the various varieties by their root systems; the cion must cause the difference, because the stocks are mostly the same.

13. *Disease infection.* Diseases may be imparted by stock to cion, for example, Peach yellows.

14. *May shorten life.* Apples grafted on Pears or Pears on Apples are short lived. Grafting a weak growing cion on a strong stock also shortens the life of the tree.

15. *Avoiding suckers.* One reason for budding the Lilac upon Privet is to avoid the bad habit of suckering common to the Lilacs.

LIMITS OF GRAFTING

The problem as to just which plants may be grafted upon one another is still far from complete solution. Certain species graft with perfect ease, certain other species in the same genus are united with difficulty. Peaches do not bud readily on the Apricot, but both the Peach and the Apricot may be budded on the Plum. Apparent similarities are confusing. The Horse Chestnut cannot be budded on the Oak, but the edible Chestnut may be so united. Botanically, the Chestnut and the Oak are of one family. Plants belonging to different families cannot be grafted. It is, however, possible to have the Mountain Ash, the European Quince, the Japanese Quince, the June Berry, the Crab Apple, the Pear, the Medlar and the Cotoneaster all in bloom on one Thorn Apple or Cratægus tree. All of these plants belong to the Rose family.

The late Dr. Frank N. Meyer, well-known plant hunter of China, writes of some interesting grafts made by the Chinese. In the Transactions of the Massachusetts Horticultural Society, he says: "It is strange to see how the Chinese gardeners with their primitive methods have learned how to master the propagation of certain plants. One finds, for instance, that in North China Chrysanthemums are grafted upon a biennial Artemisia which is very resistant to drought, alkali and rough handling. In Central China again, where there is no alkali, a perennial Wormwood, *Artemisia vulgaris indica*, is used for the same purpose.

"In the provinces of Honan and Chili, *Syringa Meyeri* is grafted on *Ligustrum Quihoui*, while around Shanghai, *Syringa oblata* is put high up on *Ligustrum lucidum* so as to make standard specimens.

"The Tea Olive, *Osmanthus fragrans*, which grows on its own roots in Central China, is grafted on the Chinese Fringe Tree, *Chionanthus retusa* in the province of Shantung, while in the other northern provinces one finds it grafted on *Ligustrum Quihoui*. In Peking and Tientsin, *Prunus triloba*, *Prunus tomentosa*, flowering Apricots and flowering Peaches, are all grafted on the remarkable drought and alkali resistant, *Amygdalus Davidiana*, and since this stock is a very early one, the Chinese use it extensively in forcing.

"The tree Peony, *Pæonia suffruticosa*, is generally grafted on the roots of a very hardy herbaceous Peony, *Pæonia albiflora*. Various species of rare Junipers are put on Oriental Arborvitæ stock, *Thuya orientalis*. The ordinary Pear from North China thrives to perfection on a very drought resistant stock which bears fruits not larger than Peas, *Pyrus betulæfolia*. The Persimmon, *Diospyros Kaki*, is grafted in North China on the 'Ghoorma,' *Diospyros lotus*, while in Central China wild forms of Kakis are employed.

"In Soochow I have seen a yellow-berried Ivy, *Hedera himalaica*, grafted high up on the stem of an Aralia, and a large flowering Snowball, *Viburnum macrocephalum*, put on the stem of another species of Viburnum, while in Shansi, standard tea Roses are grafted on strong stems of *Rosa xanthina*, which is very resistant to alkali and dry heat."

Absurd statements concerning graftage have continually been made by persons who have allowed their imaginations to rule their writings. Even Virgil speaks of Apples growing on Plum trees—a core fruit on a stone fruit. We believe such things impossible. Martial speaks of the Cherry on the Poplar. Madame de Genlis claims to have grafted the Rose on the Black Currant, to obtain black Roses. A prominent New York newspaper published with seeming sincerity the account of a *table d'hote* tree which, by grafting, grew Tomatoes, Cucumbers, Potatoes, Apples, and a dozen other crops on one specimen. It was advised for planting in the small backyard!

SO-CALLED GRAFT HYBRIDS OR CHIMERAS

In 1826, at Vitry, France, M. Adami grafted *Cytisus purpureus* upon *Laburnum vulgare*, and there came from the point of union a branch which was hybrid in nature. It bore pink, yellow and

purple flowers. Yellow flowers are characteristic of *Laburnum vulgare*, and purple flowers are borne by *C. purpureus*, but the pink is truly intermediate. The wood and foliage accompanying each type of flower followed the characteristics of the parent from which it came. This graft was propagated and is known as *Cytisus Adami*. Biologists are not willing to call this a graft hybrid, however, for they point out that the tissues are not hybrid. The outer tissues of *C. Adami* are distinctly *C. purpureus* and the inner tissues *Laburnum vulgare*.

Many other examples of so-called graft hybrids have been found. In 1914, D. Bois, in *Revue Horticole*, reported the case of a Pear grafted on a Quince, which sent out *below* the graft two opposite branches; one was of the Quince growth, the other differed widely from both Pear and Quince. It was called *Pyrocydonia Winckleri*.* It is reported that this variation is propagated true to type.

The settlement of the question whether such growths are truly hybrid is important, for if they are, sexual and asexual reproduction are identical. Hybrids are supposed to occur only as the result of the union of the sex cells, not the structural cells, of a plant.

CHARACTERISTICS OF AN IDEAL STOCK

A good stock for budding or grafting should be:

1. Hardy, if possible, so that the plants may live through the Winter.

2. Easily, simply and rapidly multiplied.

3. Cheap to obtain; many stocks are grown from seeds gathered from the wild.

4. Free from susceptibility to pests and diseases. Certain plants being very susceptible to pests are grafted for this reason. The European Grape being readily attacked by the Phylloxera, a root louse, is grafted upon the American Grape stock which is not attacked. Diseases are readily communicated from stock to cion or *vice versa*.

5. Easy to work; looseness of bark for budding is a prominent asset.

6. Capable of making good strong unions and uniting quickly; the cion should not outgrow the stock.

7. Able to produce a good, well-balanced root system. In the case of many commercial plants, a small but very fibrous root sys-

* Bois, D. Pyrocydonia Winckleri. Revue Horticole, Jan. 16, 1914, pp. 27-29.

tem is preferred, because it permits of easy transplanting and later the ablity to fertilize the limited area about the plants. Long wiry roots are often the only ones produced when seedling stocks are raised in a heavy soil. A loose, fibrous soil containing leafmold will cause such trees as Hickories, Oaks, English Walnut, and Chestnut to make fibrous roots. To get a desirable root system Fuller* advises sowing nuts "in shallow pots or boxes, and in nearly pure sand, applying liquid manure as needed, to insure a vigorous growth."

8. Non-suckering. Suckers are always a nuisance because they must be removed, else they will often outgrow the cion.

9. Adapted to a wide range of soils. The adaptation of a stock to both sand and clay will go far toward making the success of a variety from the commercial standpoint.

10. Straight stocks for weepers and standards. For grafting this class of plants, a crooked stock is objectionable. During the Winter or early Spring cut down the plants and encourage one shoot only to grow, cutting out the weaker ones. In growing stocks for weepers the growth of a leader is not stopped, for side shoots are not wanted. Stocks for standards can often be stopped after reaching the proper height, or they can be pruned in order to form a head the same season.

SELECTION OF WOOD FOR CIONS

The material for making cions should be collected, preferably in Midwinter, and is best stored in moist sand or sawdust and kept cool. The wood may, however, be gathered any time before the buds start in the Spring. For making cions choose the strong, vigorous wood of the previous season's growth which has plump, matured buds on each branch. Water sprouts are not the best sort of wood to use.

TIME TO GRAFT

Grafting is usually done when the buds of the stock are beginning to swell, which indicates that the sap is now active. As the different trees and shrubs vegetate at various times in the nursery there is a well-planned succession of grafting seasons for the various species of plants. This advice applies also to greenhouse propagation. The roots must be active at the time of grafting although the tops need not necessarily be growing,

* Fuller, A. S. The Propagation of Plants.

THE IMPORTANT POINTS IN ALL GRAFTING

Plants which can be grafted have a layer of bark covering the wood. Usually this bark, at least on the young branches, will peel from the wood. It is absolutely essential that the tissue between the bark and the wood of both stock and cion be in contact. This is known as the *cambium layer*, and that of the cion should touch the cambium of the stock at as many points as possible. It has the ability to grow wood tissue from its inner side and bark from the outer; by thus knitting together the tissues heal over nicely.

After the graft is made, especially in outdoor work, the entire cut surface of both stock and cion must be waxed over to check evaporation from the tissues.

A B

Fig. 52.—Whip or tongue grafting. A, Stock and cion properly cut. B, The parts fitted together and wrapped with waxed string

Grafts may be made: (1) upon seedlings, a method especially used in propagating horticultural varieties of ornamental trees and shrubs; (2) upon young trees, as with Apples and other fruits; (3) upon the trunk and branches of older trees; (4) upon roots; or (5) upon the crown of a plant.

WHIP OR TONGUE GRAFTING

Whip grafting is largely used when working on small stocks. Both the stock and cion are cut diagonally; the cut should be long and straight. A vertical cut is then made in both. Practice will show that this cut must be made a trifle to one side of the middle of the diagonal cut. The two parts are fitted together as shown in fig. 52. Care must be taken to have the cambium layers in contact. If the stock is larger in diameter than the cion, the cion must be placed at one side. The union is then wrapped with waxed string or raffia. The waxed string used is No. 18 knitting cotton, the balls being soaked in melted grafting wax and laid away to dry. This string is just weak enough to be broken by the hands. In whip grafting Pears, it seems best to wax the

grafts rather than use the string. In order to harden the wax quickly the grafts are dropped in a pail of water.

ROOT GRAFTING

The whip or tongue graft is the most common method of root grafting Apples. The stocks are dug and stored in Autumn and grafted in January or February. As this is done indoors, it is often known as *bench grafting*. Whole roots may be used, the grafting being done upon the crown. Sometimes, however, each root is cut in two pieces, in which case two grafts may be made. The cions are often made longer than in ordinary whip grafting, the object being to have the point of union deep in the soil when the graft is planted, thus producing what is known as "own-rooted" or "cion-rooted" trees. In colder regions orchardists prefer the "cion-rooted" trees, believing that the varieties grown upon them are often hardier. This discussion is continued on the next page.

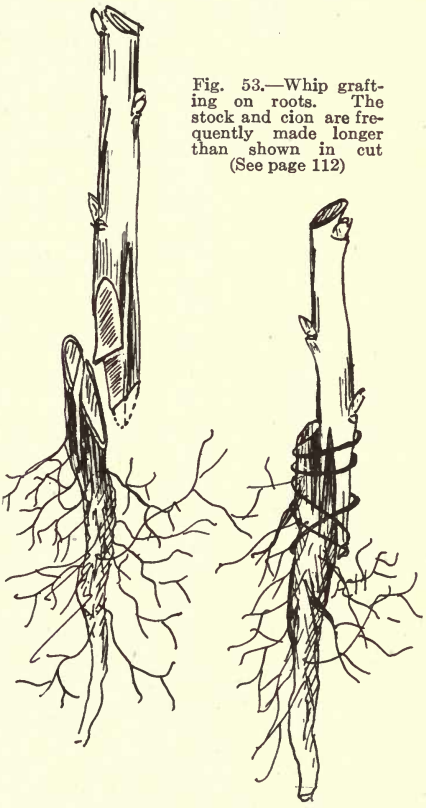


Fig. 53.—Whip grafting on roots. The stock and cion are frequently made longer than shown in cut (See page 112)

The grafts are wrapped with waxed string and packed in bundles in moist sand or sawdust, green sawdust frequently being used. The grafts being made at the nursery, the green sawdust ferments and remains moist enough to cause good unions so that boxes of grafts may be shipped from the East to the growers of trees in the Middle West with perfect confidence that the grafts have callused without the need of examining or repacking in the Spring. The grafts

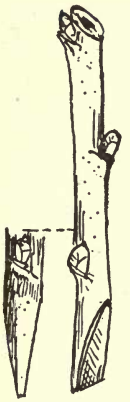


Fig. 54.—Cions for cleft grafting.

are best stored in a cool cellar, care being taken that the bundles are labeled at the time of packing so that as soon as the weather permits, the grafts may be planted. For extensive planting furrows are turned, the grafts are set in place, and the soil is thrown back and firmed, either by hand, with tamps, or by means of a machine with heavy oblique wheels which press the soil about the grafts.

It should be said of root grafts that they offer an easy entrance to crown gall and for this reason some orchardists fear to use stock so propagated. The nurseryman or orchardist who feels sure that he has no crown gall may safely use this method.

Incidentally, the tops of seedlings may be inserted in a row and used as hardwood cuttings to produce a crop of stocks for future grafting.

Relative to cion root production, some nurserymen have been able to demand a higher price for cion-rooted stock because the purchasing orchardist has felt that the trees were superior to ordinary root grafts whose seedling roots were tender. However, in experiments conducted from 1914 to 1919, J. G. Moore,* of Wisconsin, found that cion root formation depends much upon the depth of planting and the amount of moisture in the soil. At the end of three years in the nursery not over 3.8 per cent of the varieties tested produced cion roots in sufficient abundance to support the tree were the roots of the stock to Winter-kill. The production of cion roots was proportional to the depth at which the grafts were set. Those set 6 inches deep produced better roots than those set 2, 3, 4, or 5 inches deep. But it would seem safe to say that the roots formed on cions are generally too meagre to greatly influence hardiness.

CLEFT GRAFTING

Cleft grafting consists in splitting a stock after it has been cut off perfectly square and inserting one or two cions. These should be cut wedge-shaped at the base (see fig. 54) and of equal size. In cutting the wedge great care should be taken to have both sides straight, neither lopsided nor scooped out. The lowest bud on the cion should be just above the cut sides of the wedge. A

* Moore, J. G. Scion Root Production by Apple Trees in the Nursery. Proceedings of the American Society for Horticultural Science, 1919.

special tool may be used to make the cleft and hold it open while the cions are being inserted. (See fig. 55.)

Cleft grafting is used principally when the stock is over one inch in diameter, making it possible to insert two cions. Should both grow, the weaker is cut out at the end of the first year. As in all grafting, the cambiums of both should be in contact. To insure this, the cions should be inserted a trifle diagonally. (See fig. 56-A.)

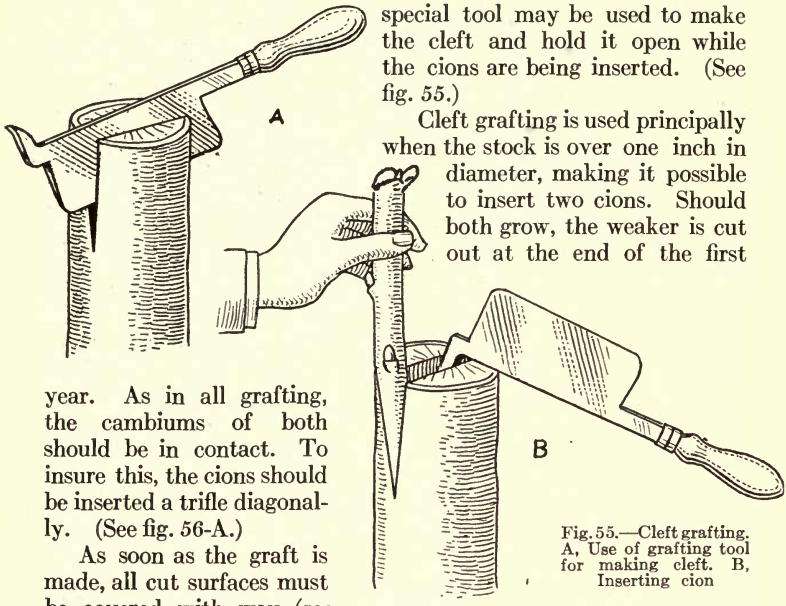
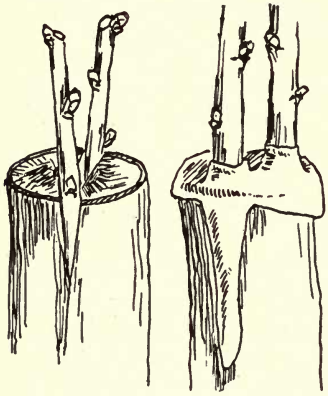


Fig. 55.—Cleft grafting. A, Use of grafting tool for making cleft. B, Inserting cion

As soon as the graft is made, all cut surfaces must be covered with wax (see fig. 56-B); a slight dab should even be placed at the end of each cion.



A B

Fig. 56.—Cleft grafting. A, The completed graft. B, Properly waxed

Cacti are easily cleft grafted, Pereskia (see fig. 56) and Cereus being the common stocks for such Cacti as Epiphyllums, which are very drooping (see p. 132.)

Peony roots may be cleft grafted, especially *Pæonia Moutan*, which is grafted either on the herbaceous or the shrubby stock. Bind the graft with copper wire; raffia decays before the union takes place.

VENEER GRAFTING

Veneer grafting (see fig. 57) is practiced mostly in the greenhouse upon ornamentals. The graft is very simply made, a chip being cut

from the stock and a piece of cion of equal size fitted on the place. In the greenhouse a ball of moss around the union is sufficient. When done out of doors, the cut edges must be thoroughly waxed. The stock need not be headed back until the cion is growing nicely. Certain plants which are more difficult to graft are best placed in a propagating case, or grafting frame (see p. 66), where the atmosphere can be confined. Many of the evergreens and Rhododendrons are propagated by this method.

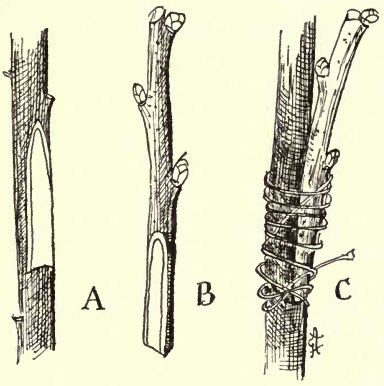


Fig. 57.—Veneer grafting. A, The stock notched. B, The cion cut to fit the stock. C, Stock and cion together

SIDE GRAFTING

Very closely resembling the veneer graft is the side graft. A diagonal cut is made in the stock, which should be long. Note the sketch (fig. 58), which shows how the cion is made and inserted

Fig. 58.—Side grafting the Rose. The cut in the stock should not be so nearly through the stem and is best made longer and more acutely than shown in the sketch

into this cut. Plants may be propagated by this method either when in full growth or when dormant. Waxing is necessary out of doors; tying with waxed string indoors holds the cion in place. If the stock is headed back slightly, the growth will be encouraged.

SPLICE GRAFTING

An exceedingly simple form of grafting is the splice graft. Stock and cion are cut with a long diagonal cut as for the whip graft. The two parts are tied together without further fitting, although the stock and cion should be approximately the same size. Frequently a pin is pushed into the pith of the stock, its head removed and the cion forced down over it; the pin thus takes the place of the tongue in a whip graft. This method is used on Roses (see page 167) and Cacti (see fig. 59), and is only successful in the greenhouse. It is a good method for soft wooded plants which can not be split easily.

SADDLE GRAFT

In making the saddle graft the stock is cut in the form of a wedge. The cion may either have a section removed to fit over the wedge or it may be merely split upward (see fig. 60). This method is successfully employed in grafting Rhododendrons.

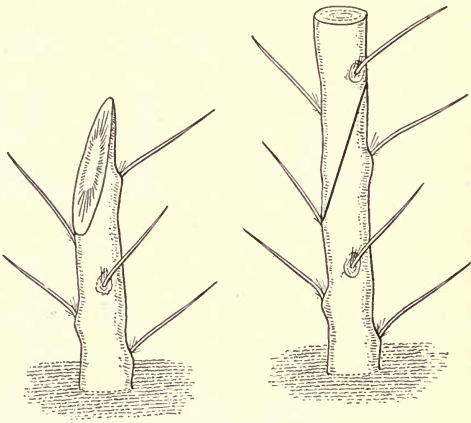


Fig. 59.—Splice grafting Pereskia Cactus
(See page 93)

BRIDGE GRAFTING

When trees are girdled or injured by rabbits or cultivators so that the bark is injured, the wound may be encouraged to heal and the sap caused to flow, by bridging the injury with cions cut wedge-shape at each end pushed in between the bark and wood. Use a knife to open an entrance for the wedge of the cion. The exposed cut areas must be waxed. (See fig. 61.) Sometimes suckers or seedling trees, rooted at the base of the injured tree are used as cions. This is usually successful because the cions are rooted and growing vigorously.

This method has been widely used in saving mutilated fruit trees in France.

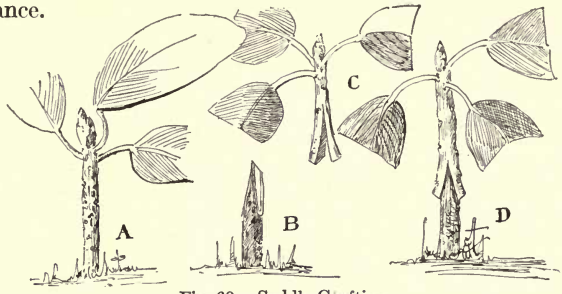


Fig. 60.—Saddle Grafting.
A, Seedling Rhododendron. B, Stock. C, Cion. D, Completed Graft.

"Throughout the entire district devastated by the Germans there were thousands of trees from the trunks of which the Germans had cut off a circle of bark. A few days' exposure of the girdled space to the sun would be sufficient to kill Peach, Plum, Apple, Apricot, and Cherry trees.

"So great was the number of trees that had to be dressed in this way that the entire available supply of grafting preparation was quickly exhausted. Tar was then used as a substitute, and, finally loamy clay."*

CROWN GRAFTING

The crown graft is a slight modification of the cleft graft. In this case the stock is not split, but the cions are cut in various shapes and fitted into cuts in the stock. The cions may be tapered as in the cleft graft or they may be cut off straight at the base as in fig. 62. Another kind of crown graft is made by removing triangular chips from the stock and using a cion to fit. A special inlaying tool is used for the purpose. (See fig. 63.) Crown grafting is used extensively upon very large trees which have been cut down. Many cions may be inserted. They must be tied and waxed in place. To prevent transpiration it is best to cover the whole stump with wax paper. The unions will not be very strong and some support

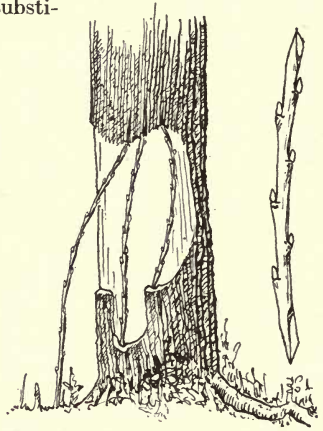


Fig. 61.—Bridge grafting. Note how the cions are cut to fit into v-shaped incisions in the bark (See page 116)

* Wood, Henry. From an article reported in the *Literary Digest* from the *Westminster Gazette* (London).

should be provided at the start, for, when the cion grows, little surface should be exposed to the wind.

In the devastated areas where trees were cut down, the French have crown grafted many trees. Regarding this the *Literary Digest* reports the following comment from *L'Illustration* (Paris, April 28, 1917):

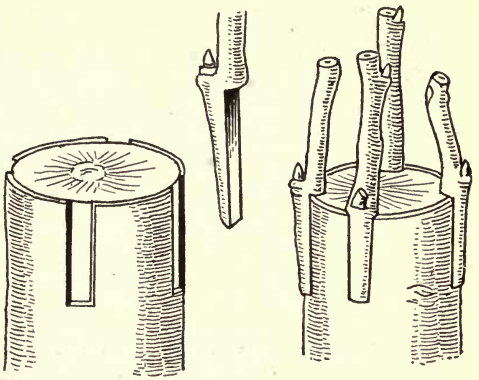


Fig. 62.—Veneer crown grafting. This is a modification of the crown graft (After Baltet)

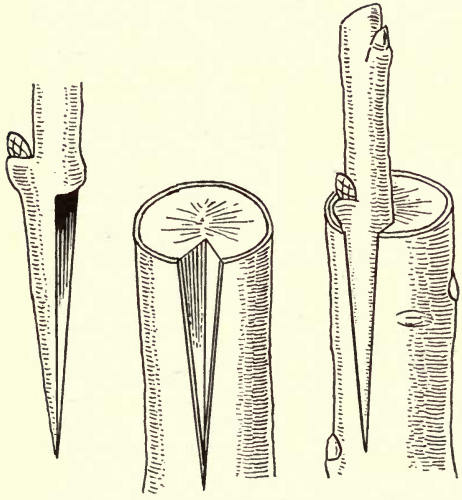


Fig. 63.—Inlayed crown grafting. It is well to have a special inlaying knife for cutting this sort of a crown graft but it can be made without one. The cion is cut with a triangular face with a notch which will act as a support upon the stock. By placing the cion upon the stock the section of wood can be marked with a knife and easily removed (After Baltet) (See page 117)

"The work of reparation was taken up in time, and Nature was given a chance to act. When the bark of the oldest trees was too deeply grooved to admit the passage of young sap, the old trees were eliminated, and trunks not exceeding 25 centimeters in diameter were left to send up shoots. Four or five of the most vigorous of the shoots will be used for grafting-slips next year.

"Some of the trunks saved have been grafted even with the ground when planted, so the new growths, springing from the trunks at a height of 80 centimeters, will bear, above the graft, exactly the same kind of fruit that the tree bore at first. Other trees not the issue of grafts, but seedlings, whose bark has not been roughened by age, are expected to recuperate very rapidly.

"When the mutilated tree did not measure more than 20 centimeters in diameter the 'crowning' method has been used. This means that the trunk has been sawed in a slightly oblique direction to facilitate the shedding of the rain (fig. 64, a), and then from three to six grafting-slips have been inserted all around the trunk, between the bark and the wood. Grafting-slips for use in the 'crowning' method are prepared as shown in figs. 66, b and c, and set in 8 or 10 centimeters apart, the space varying according to the diameter of the trunk (fig. 64, d). When set in place, the graft-slips are ligatured, and the whole surface—wound, bark, and ligature—carefully covered with grafting wax. The slips (which must be in a state of complete rest) will be found in France growing in a crown around the top of the mutilated trunk. . . ."

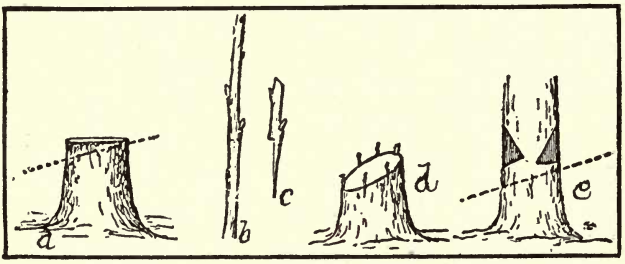


Fig. 64.—Crown grafting in war zone. (From *L'Illustration*, Paris)
(See page 118)

TERMINAL BUD GRAFTING

With certain plants the tip of the twig of a seedling is split lengthwise through the terminal bud and a cion is inserted as in the ordinary cleft graft. According to Baltet, this method, known as terminal bud grafting, is performed upon the Walnut and the Pine. It is best practiced indoors and is here presented in the hope that it may prove a method by which some other difficult plants may be grafted.

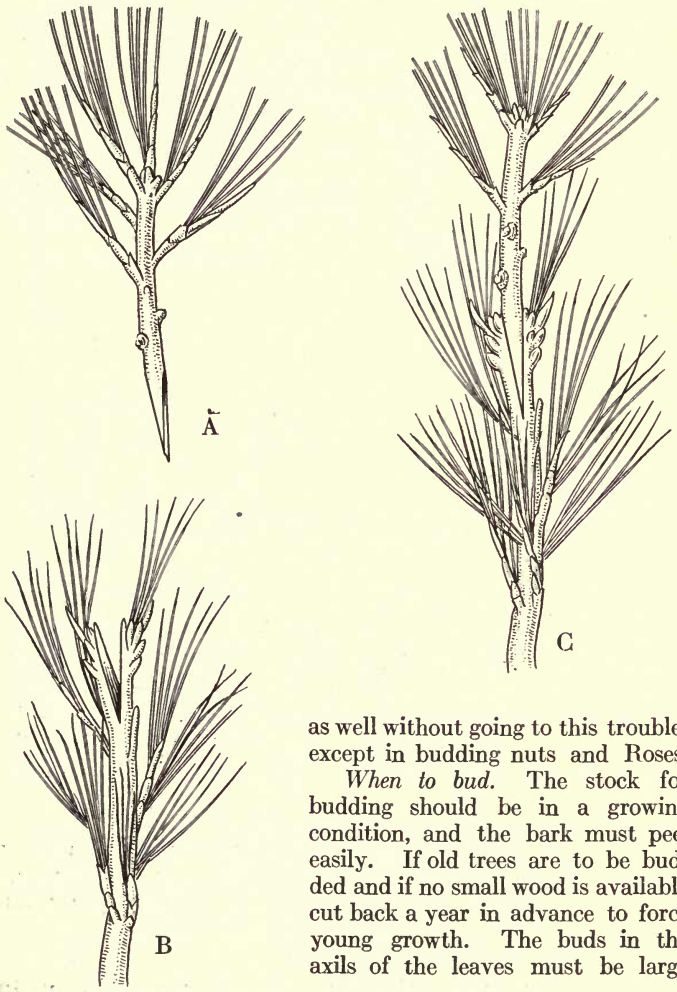
SPRIG BUDDING

A method of grafting, known as sprig budding is shown in Fig. 69. Strictly speaking it is not budding, but grafting, in that a cion rather than a single bud is used. The photograph is self-explanatory.

BUDDING

When the cion is merely a bud, the process is known under the specific name of *budding*, a term less accurate than the French term

bud grafting. The bud is usually accompanied by a small piece of bark, and generally most buds will carry also a small piece of wood. If done carefully the wood is best removed, but the buds grow fully



as well without going to this trouble, except in budding nuts and Roses.

When to bud. The stock for budding should be in a growing condition, and the bark must peel easily. If old trees are to be budded and if no small wood is available cut back a year in advance to force young growth. The buds in the axils of the leaves must be large

Fig. 65.—Terminal bud grafting. Pine. The tip of the stock (B) is split and cion (A) is inserted (C) (See page 119)

and plump because immature buds do not grow. The bud wood or bud stick should be kept in moist paper or sphagnum moss as soon as cut.

Prof. U. P. Hedrick, horticulturist of the Geneva Experiment Station, gives the following dates for budding:

Apple. July 15 to August 1
Cherry. Mazzard, July 20 to August 1
Mahaleb, August 20 to September 1
Peach. August 20 to September 10
Pear. July 10 to 15
Plum. St. Julien, July 15 to August 1
Myrobalan, August 15 to September 1
Quince. July 25 to August 15
Rose. July 1 to 10 (See p. 170)

An expert budder will insert from 2,000 to 3,000 buds in a day, employing helpers to do the tying. In actual commercial budding the budder follows along a row of seedlings, passing over those not large enough to work. The budder rests upon one knee, makes the cuts and inserts the buds which he removes from bud sticks carried in a small burlap sack slung over his shoulder. A boy follows with the raffia cut to convenient lengths, and ties the bud.

SHIELD BUDDING

The bud stick. This is the simplest method of budding. The buds are cut from the bud stick, holding the branch as shown in fig. 66, with the top end toward the budder. The cut is made downward and as smooth as possible. Cut off the leaf blades leaving the petiole as a handle. Professional budders prepare the bud stick by cutting the buds almost entirely through, allowing them to hang so that they may be removed just before they are inserted in the stock.

The stock. The stock is best gone over several days before budding time so that the weeds may be removed from the base of the plants. Interfering leaves and branches up to four or five inches from the soil are also cut out, but this should not be done long before the plants are budded else the bark will become hard. In most nursery budding, except for weeping varieties and standards, the buds are inserted an inch and a half above the soil.

The budding knife should have a thin blade with a rounded end. It must be of razor sharpness.

Making the cut. First a T is cut in the stock (see fig. 67), care being taken that the cuts are just through the bark, not into the wood; this may be right-side up or inverted. Much is being said of late in favor of the inverted T. The buds inserted in such a cut certainly shed the water better. The edges are peeled back with the rounded point or bone handle of the budding knife, and the bud

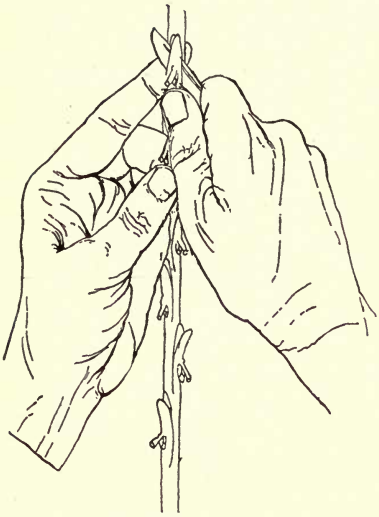


Fig. 66.—Cutting buds. The sketch shows the proper position of bud stick and the hands. The bud is only partially removed from the twig until ready for insertion; then the bud may be easily cut straight across

water; the whole cut surface is covered but the bud must not be injured nor covered.

If the bark is too tight above ground a little soil may be dug away from the plant and the bud inserted upon the crown of the plant or even upon the root.

If the bud is "taking" it will look fresh and alive, but if not, the bark will peel away from the sides of the bud and it will be dried and brown. In the latter case, another bud may be inserted.

About ten days after budding, the buds will have united with

is inserted so that it fits flatly. Should a piece of bark protrude above the bud it may be removed. Some propagators make the top of the T crescent-shaped instead of square, by holding the knife at an angle of 45 degrees to the stock and making the cut with a rocking motion. The longitudinal cut is started an inch below the crescent and brought upward, the forefinger guiding the blade. The knife is quickly moved to the right and left when the cross cut is reached, to open the T. The bud is then inserted.

Buds are usually placed on the north side of the stock so that they will be shaded.

After the bud is inserted it is tied with raffia to keep out the

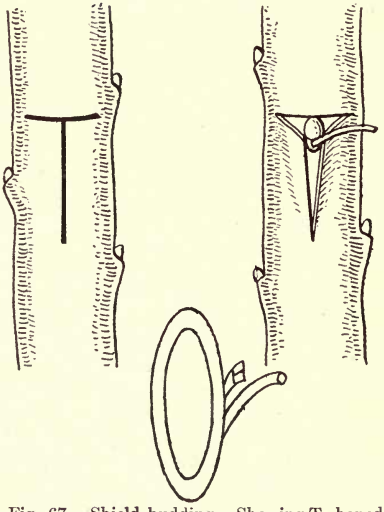


Fig. 67.—Shield budding. Showing T-shaped cut in stock; the bud and the budded tree

(See page 121)

the stock and the raffia should be cut, else the young buds will be strangled or start to grow. Plants budded early will often start to push a shoot, which often Winter-kills unless protected with soil the first Winter. The top may then be cut off entirely or it may be sawed partially through and the top bent over. Eventually, however, the top should be removed. With plants budded later the bud will remain dormant through the Winter and start in the Spring. In this case, the main shoot should not be cut until after the bud has grown in the Spring. (See fig. 68.)

Fig. 68.—A budded seedling tree. Note that the bud at the base has started to grow. The top can now be removed

June budding. In the South June budding is commonly practiced but it is not common in the North. Buds for this work are secured by cutting shoots of the desired sorts before they sprout in Spring, and keeping them in a dormant state in a cold cellar, or even buried outdoors. Budding is done as soon as the bark peels in June. In the June work the bud can be placed a foot or more from the soil so as to increase the height of the tree when offered for sale. Below this height branches are not wanted on a Peach tree, so it is immaterial what the part below the seedling is. The stock should be headed back to about six inches above the bud. As soon as the union is assured, strip the foliage from the part above the bud; but do not cut the stem away until later in the season, as it provides a stake to which to tie the growing bud. It is better to leave the foliage below the bud for awhile, cutting it away gradually as the bud advances. To strip it all off as soon as the bud starts has a weakening effect, which is soon perceived.

PATCH OR FLUTE BUDDING

It is much more difficult to make a successful *patch bud* than a shield bud. The bud is cut from the branch with a square of bark and a square the same size is cut from the stock (see figs. 70 and 71.) The bud must fit nicely into the stock, otherwise the union is difficult. This method is used mainly with very thick-barked plants and is done in the late Spring.

When a whole ring of bark is removed with the bud, the process is called *ring* or *annular budding.* (See p. 195, fig. 97.) This is merely a modification of the patch bud method and is sometimes used on the Grape. Patch budded plants are treated just as are the shield budded ones.

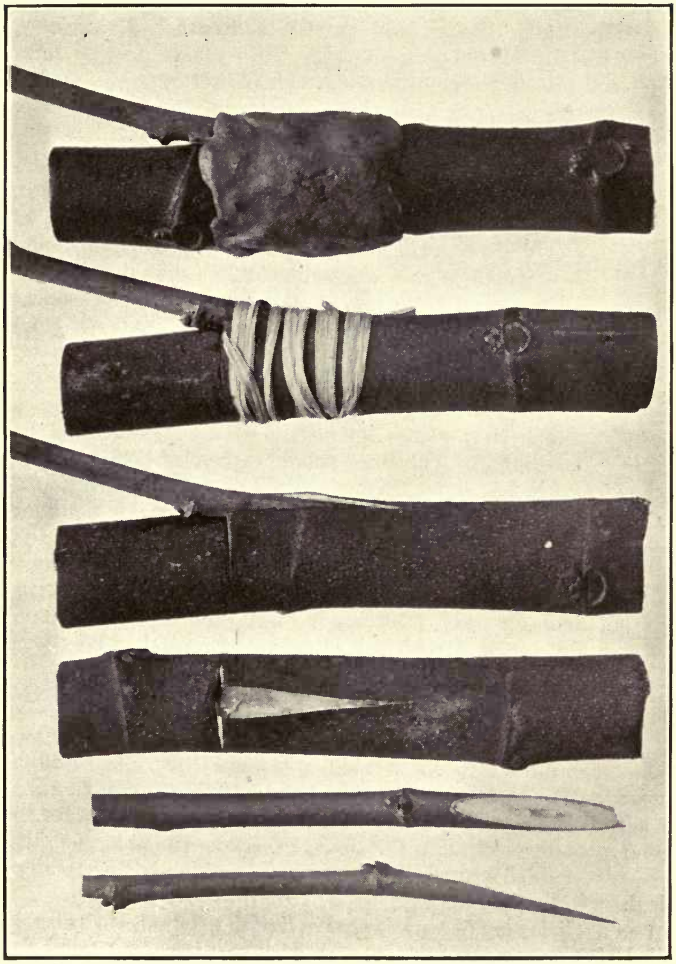


Fig. 69.—Sprig budding, showing the successive operations; instead of a single bud a whole branch is used

H-BUDDING

The nature of the H-budding method can be readily seen from the sketch (fig. 72). An H is cut in the bark, the bud is inserted beneath the two flaps and bound with raffia.

INARCHING

Inarching is a method of approach grafting. It is a simple method, in which a portion of bark is cut from the stems of two plants (see fig. 73-A) which are then tied securely together so that the cut surfaces of each may knit. Both plants are growing at the time.

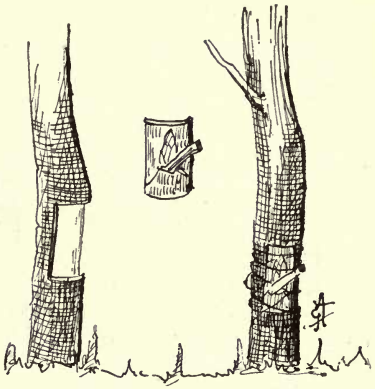


Fig. 70.—Patch budding

When the plants have united, one of them is cut from its root and allowed to grow on the roots of the other. At the same time the head of the undesirable sort is removed. There are modifications of this simple method in that the parts of the plant are frequently joined by a tongue graft (see fig. 74).

Beech, Birch, Maple, Larch and various evergreens are often increased in this way, whenever desirable varieties cannot easily be increased in any other way. When stocks are to be used in this way,

Fig. 71.—Patch bud of Mango. The patch bud is well adapted for budding thick barked trees

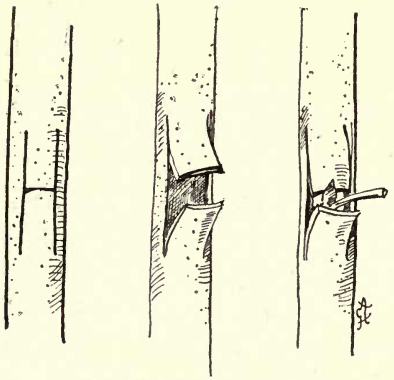


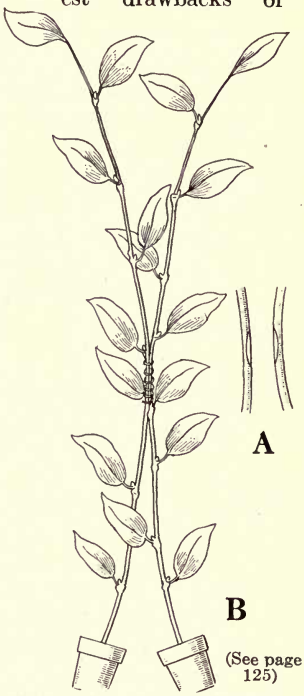
Fig. 72.—H-budding (See page 125)

horticulture is the time required to test a new variety originated from seed, and that any method which shortens the time required to make such tests must appeal to everyone, whether an originator or a tester of new varieties, as of the greatest value.

Mr. Oliver writes: "It was discovered by the writer that a large number of hard wooded shrubs and trees are capable of very rapid increase when propagated by processes which may be termed the seedling-inarch and nurse-plant methods.

"These methods are inexpensive and, owing to their simplicity, may be used by persons without previous experience in the propagation of plants. By these methods the ever-increasing number of plant breeders will be able to save much time in determining the value of hard wooded plants raised by means of hybridization. They can be used in manipulating seedlings of rare trees and shrubs intended for crossing, so that it is best to get them well established in pots by potting them in March. It is still better to pot them a year in advance.

A quick method of testing seedlings. Dr. David Fairchild, in the introduction to G.W. Oliver's bulletin on the seedling inarch (1911),* remarks that one of the greatest drawbacks of



(See page 125)

Fig. 73.—Inarching. A—The method of cutting off a slight amount of bark of both plants to be inarched. B—The two plants tied together.

* The Seedling-inarch and Nurse Plant Methods of Plant Propagation, U. S. Dept. of Agri., Bur. of Pl. Industry, Bull. 202

each plant will bloom in a much shorter time than if left to grow on its own roots. Seedlings of all hard wooded plants, from seeds collected by travelers in foreign countries, may thus be quickly brought to the flowering stage and their value determined.

"The most remarkable feature of the new methods lies not only in their simplicity, but also in the certainty with which unions result. The writer has had very few unsuccessful unions and none among those classes of plants where the most suitable stocks are known and in common use. Not only is it possible to inarch a seedling a few weeks old to a large stock, but a moderate sized seedling stock can be inarched to a shoot of a rare shrub or tree having the same diameter as the stem of the seedling. A satisfactory union may thus be induced where other methods of a sexual propagation have invariably failed.

"Rose seedlings resulting from variety crosses inarched when from three to four weeks old on Manetti stocks have produced maximum sized flowers long in advance of seedling plants growing on their own roots. The rare Finger Lime, *Citrus australasica*, sometimes seen in a dwarf, sickly condition in greenhouse collections, has borne fruit two years after inarching on one of its congeners; and within nine months after flowering, hybrid seedlings between this Citrus and a cultivated Orange were in their turn inarched on 2-year-old Lemon seedlings.

"Very young seedlings of hundreds of other rare, hard wooded plants may be worked on the same or allied species or genera, and their value determined much in advance of the time when they would flower on their own roots, or on plants obtained by grafting or budding from the mature shoots of the seedlings.

"Hard wooded seedlings which need to be flowered in the shortest possible space of time, in order to determine their value, are used for inarching as soon as the first leaves attain a fairly firm texture, as, for example, in the case of the Mangosteen. But when seedlings are used as stocks for the vegetative propagation of established varieties by uniting the stocks to small branches, then larger seedlings are used as, for example, in the case of the Mango.

"Seedlings raised from seeds of new and rare trees, shrubs, and vines may be induced to grow very quickly if used as cions when a few weeks old, by inarching to strong-growing plants of other species of the same genus, or in some cases on species of other genera of the same family. This has been done recently with such plants as Chestnuts, Walnuts, Hawthorns, Oaks, and many others. It is not necessarily done for the purpose of hastening the flowering

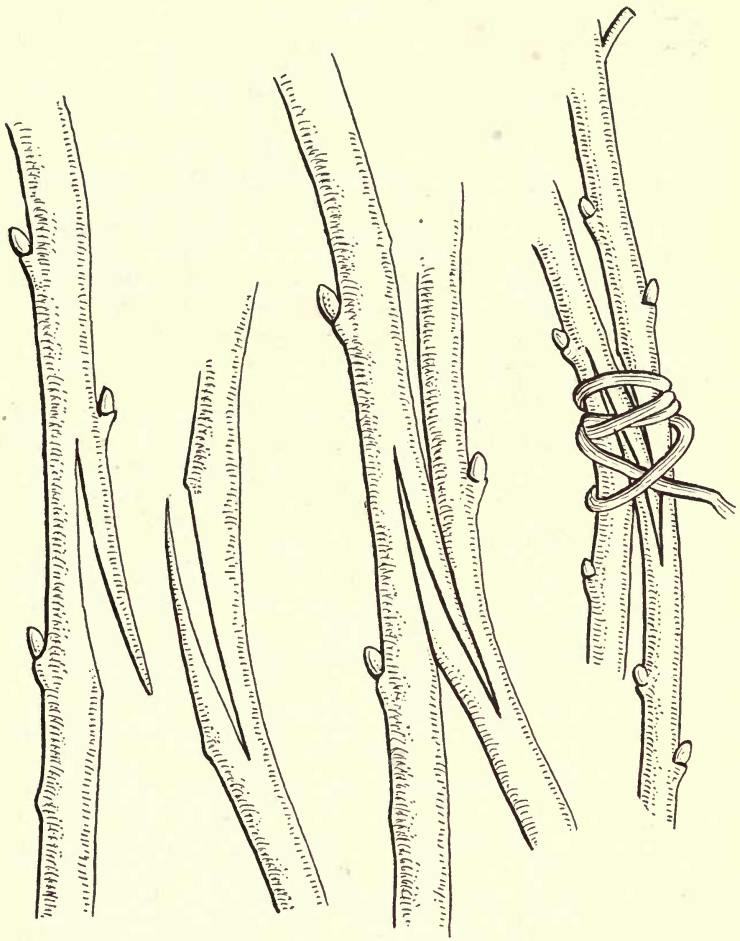


Fig. 74.—Modification of inarch. Instead of simple inarching; the two plants to be inarched may be cut with tongues which will fit together (See page 125)

or the fruiting of new plants, but to give quickly an abundance of material for propagation by budding or grafting when the new material is assumed to be valuable.

"If a hard wood seedling of hybrid origin is tied to a large stock and they fail to unite, there is little or no danger of losing the

seedling, provided its roots are kept damp during the attempt. If the inarch is not successful, the seedling can be repotted and grown in the usual way.

"It is well known that many seedling Roses on their own roots produce flowers before the cotyledons decay, but the flowers are necessarily small and have little to indicate their eventual value. The seedling-inarch system shortens very considerably the period between germination and the production of flowers of maximum size—rendering a material aid to the breeder in determining the value of the seedling within a few months after germination.

Fig. 75.—Seedling Roses. Note that the seedlings are potted at the side of the pot in two-inch pots

INARCHING ROSE SEEDLINGS

"Seedlings of some of the Rose groups, resulting from crossing distinct varieties or otherwise, take more than one season to produce flowers of sufficient size to enable the breeder to judge of their merits. They take much longer to develop when budded on Manetti or other stocks, because in such cases a considerable time has to elapse before the growth of the seedling is strong enough to give buds and wood fit for propagation by budding or by grafting. Rose seedings three to four weeks old, or after the first few character leaves are developed, lend themselves very readily to the seedling-inarch method of propagation. Tea and Hybrid Tea seedling Roses will give flowers of maximum size very quickly after the tiny seedlings are inarched to strong-growing Manetti or other stocks, thereby saving much time in preliminary tests.

"The operation of inarching is simplified if each seedling is pricked off into a 2-inch pot (fig. 75) as near the rim as possible, shortly after the cotyledons are developed. In two or three weeks it will make sufficient growth so that it may be removed from the

Fig. 76.—Seedling Roses. The plants have been removed from the pots and wrapped in burlap (See page 129)

pot, when a little fresh soil is held in place around the root by a piece of cloth about 5 inches square (fig. 76). The ball containing the roots of the seedling is secured to the stock, the stem of the seedling being placed close to it, so that the inarch may be easily accomplished. (Fig. 77.) The union is a rapid one and becomes perfect some time before the cotyledons decay."*

GRAFTING WAX

A wax composed of resin and beeswax is most successful in this country. In certain European work, waxes containing some alcohol are used, but they are apt to melt in our hot Summers. A good wax is made of four parts (by weight) of resin, two parts of beeswax and one part of beef tallow. The beeswax and resin are broken up and the whole mixture melted when it is poured into a pail of cold water. When hard enough to handle it should be worked like molasses candy, being pulled until it has a grain and becomes a creamy light brown. When applying it, grease the hands well. The resin makes the wax hard, the beeswax gives it oiliness and the tallow keeps it soft.

* Author's Note.—As above described, a small piece of bark is removed from both stock and cion before tying the seedling to the stock.

Besides grafting wax some other substances have been used.

Shellac has been successfully used and would seem to be simple to apply and effective, providing the solvent alcohol does not injure the tissues.

Paraffin is useful in herbaceous plant grafting. When used outside it is thought to have especial value because, being transparent, it allows light to reach the cambium thus causing more active growth.

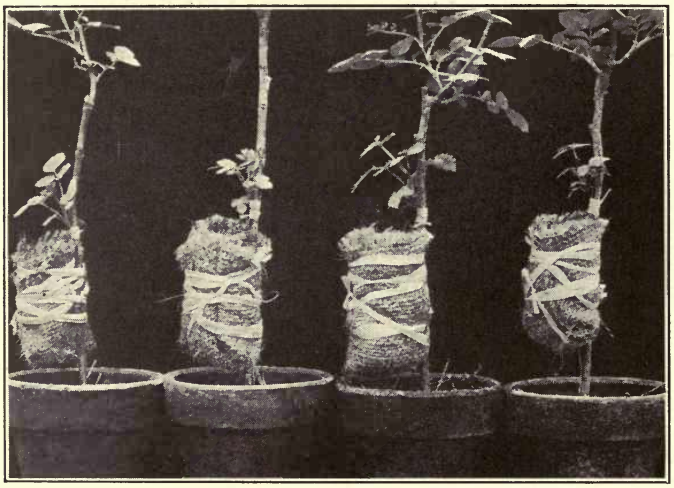


Fig. 77.—Inarched seedling Roses. Just as in figure 73-A the bark is cut on both stock and cion and tied together. The seedling Rose is tied to the rose stock
(See page 129)

Applying the wax. The wax should be applied by working it in the hands in the form of a flat ribbon. Start in one place and go as far as possible with one piece; a quarter of an inch or less is thick enough, but let all joints between different pieces of wax be thoroughly worked together so that no air nor water may enter. Cover all cut surfaces. Some workers even wax the upper ends of the cions.

Waxed string is prepared by soaking a ball of No. 18 knitting cotton for a few minutes in the kettle of melted wax. Waxed bandages are prepared the same way; the cloth should be torn into widths of a half inch and rolled before dipping into the wax.

TOP GRAFTING AND DOUBLE WORKING

Trees of an undesirable variety, even when old, can be grafted at various points in the top. It should take three or four years to work over a whole tree, certain branches being chosen each year. The younger the tree, the easier and more wuickly it can be worked. Sometimes the cions are easily blown out while still small. To avoid this strap a supporting stick along each branch and cion.

Cleft grafting is mainly used in this work. It must always be remembered that the cions will grow straight up; the clefts must, therefore, be made horizontal rather than vertical. Cut back the growing cion to make it branch instead of letting it become long and willowy.

In some cases varieties which make poor growth or are susceptible to decay at the soil line are double worked; in other words, some strong variety is root grafted on a stock, then later the second variety is cleft grafted on the strong stock.

Pears. Bosc, Dix, Dinsmore, Josephine de Malines, Marie Louise, Paradise, Shelden, Washington, Winter Nelis and some other Pears do not graft readily on the Quince. A strong growing sort, such as Duchesse d'Angoulême, Vicar of Wakefield or Diel is used upon the Quince; then the other varieties are budded a few inches above the graft.

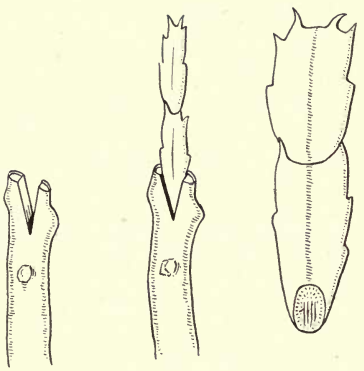
Apples. The Tompkins King, Grimes Golden and some other varieties are best top worked upon the Northern Spy.

CACTUS GRAFTING

Some Cacti are grafted to cause earlier flowering. To increase the decorative appearance of certain trailing sorts such as the Epiphyllum, or Christmas Cactus, they are placed upon upright growers such as Pereskia and Cereus. Furthermore, when plants become so decayed at their roots that cuttings are difficult to obtain, the small tip may be grafted upon a vigorous stock.

Cleft (see fig. 78), saddle and splice (see fig. 59) grafts are the most used. Each method gives a good area for the union of the parts. In preparing the stock for the cleft graft, the clefts are cut V-shaped, rather then split, and the cions should be trimmed wedge-shaped to fit the cleft. As the sticky sap of the Cactus allows the cion to slip from the stock readily, a spine from an Opuntia or a Pereskia is frequently used to pin the two together. Wm. G. Becker of the New Yoek Botanical Garden believes that grafts made indoors are benefited if waxed by having ordinary candle wax dropped on the cut surfaces.

In grafting Mammillaria, Echinocactus, Echinocereus and other globose or thick sorts, a stock is selected which is about the same diameter as the cion. The top of the stock is cut off perfectly level; the cion is cut in the same way; the cut surfaces are fitted together and tied with a cloth or soft cord.



A B C

Fig. 78.—Cleft grafting Cacti. A, The stock, a Pereskia, is prepared by cutting out a wedge-shaped piece. C, The cion, an Epiphyllum, is a short branch; a little of the outside is removed from each side of the base. B, the stock and cion fitted together

GRAFTING CONIFERS

It is often highly desirable to graft many of the conifers. A. H. Hill, in *The Florists' Exchange*, Aug. 23, 1919, says: "The propagation of conifers by grafting may refer to either (a) greenhouse grafting, or (b) outdoor grafting. The former is without doubt the most interesting mode of culture practiced by the propagator, and good results are always obtained when the necessary operations are carefully and skillfully performed.

Greenhouse grafting. In the first type the work is carried on in the greenhouse throughout the Winter and early Spring. The reason why the propagation of conifers from greenhouse grafting is so uniformly successful is that the operations are performed inside where all conditions are under control of the propagator.

The grafting of conifers as a means of propagation is only used with varieties which propagate poorly or not at all from seed or cuttings. Some varieties of *Juniperus virginiana*, such as *J. glauca*, *J. Schotti*, *J. Counarti*, and *J. elegantissima*, together with most of the garden forms of Pines, Spruces and Firs, form a list of the varieties grafted.

The necessary equipment consists of a greenhouse with the benches built up on both sides to a height of 12 inches. Over the top of the bench a close fitting glass sash is placed. This gives a closed box or grafting bench 12 inches deep, covered with glass sash. Heat is supplied from pipes beneath the benches.

Stocks for grafting. After the greenhouse with its benches has been properly arranged for taking care of the grafts, the next important detail is securing a supply of seedlings to pot for use as

understocks. The required quantity of understocks in pots is necessary before any grafting can take place, and since these seedlings are usually potted several months in advance so they may become established, plans must be made and stock secured in ample time. All Juniper varieties are commonly grafted on Red Cedar seedlings. For the Thuya forms the common American Arborvitæ is used. The Norway Spruce is a congenial stock for all the Spruces, while a Pine is grafted upon an understock which carries the same number of needles per bundle. The young seedlings in pots should be placed in the grafting house several weeks before the time for grafting is at hand, to allow for root action, which is to supply the flow of sap necessary to stimulate healing.

Making the grafts. When the understock shows a good, healthy root growth the time for making the graft is at hand. The operation consists in carefully fitting the cut edges of the cion to the cut edges of the bark of the understock and tying the cion securely in place with strong, light twine. Waxing is not necessary. The newly grafted plant is now laid carefully away in a partly inclined position in the grafting bench. The inclined position is necessary to permit the full light to fall upon the wound and hasten the healing process. The pots are imbedded in damp peat moss and the sash placed over the top of the bench. The wound starts healing immediately and the cut edges of the bark on the cion and understock gradually become firmly united. The sash is removed and fresh air allowed to enter the grafting bench for a short time every day. The fresh air aids in disposing of the excess moisture which develops inside the bench.

At the end of four weeks the cion is fairly well established upon the understock. The grafts are all gone over and a portion of the top foliage is removed from the understock to induce a greater flow of sap to the cion. The grafts are then replaced in the grafting benches, where they remain another four weeks. At the end of that time cion and stock should have become perfectly united. The balance of the top of the understock is now removed and the young grafts are placed in an upright position, with the grafting bench wide open. The season is now well advanced toward the first of April and in another month the grafts can be removed from he pots and planted in a shaded bed of well prepared soil out of doors.

OUTDOOR GRAFTING

In regard to outdoor grafting, see Van Cleef's notes under Junipers, page 199.

CHAPTER V

FRUIT STOCKS

Apples—Collecting Seeds—Sowing Seeds—Dwarf Apples—Apricots—Cherries—Peaches—Pears—Plums—Pedigreed Stock—Bud Variations.

APPLES

THE common stock for the Apple is that grown from the seed of the French Crab Apple, which is found wild in Europe. The Apples are used for cider making, the seeds being kept and sown. The seedlings are quite uniform in their growth and are supplied to the American nurserymen so cheaply that much stock is imported rather than grown from seed.

There is, however, an extensive acreage of Apple stock growing in Kansas and other parts of the Central West. Formerly quantities of seeds were collected in Vermont, but as this seed was in many cases obtained from grafted varieties, rather than from seedlings, it proved inferior and is gradually losing favor.

Collecting Seeds. Should the orchardist or nurseryman wish to save his own seed, he may collect the pomace at the cider mill and place it in a barrel of water to soak. The pulp will gradually come to the top and can be skimmed off; the seeds will settle to the bottom. Screening through two sieves cleans the seeds sufficiently. The first screen should be just coarse enough to let the seeds pass through and the second sieve should be finer, so that the fine pulp may be removed, leaving the seeds. The seeds are spread out in thin layers to dry, after which they are stored in a cool, moist place until Autumn, when they are sown.

Sowing Seeds. Apple seeds are usually sown during November in special seed beds prepared with a light sandy loam. Four feet is a convenient working width for such beds. Lath screens should be provided. In the Spring, when germination has taken place, the seeds are taken from the beds and sown in the nursery row.

Were the seeds sown directly in the nursery there might possibly be a greater chance of vacant spots due to poor germination, and at the same time the weeds would come up earlier than the Apple

seedlings. Most Apple seedlings are root-grafted (see page 112), but this often results in crown gall. (See page 113.)

Dwarf Apples. The stocks used for dwarfing the Apple are known as the Doucin and the Paradise. The Paradise is the more dwarf. Apples on Paradise stock may be planted as close as 8 to 10 feet apart; those on Doucin, 12 to 15 feet. Incidentally, it may be stated that dwarf trees are hardly as popular in the United States as in Europe for the trees are less hardy and the tree roots are at the surface of the soil and are frequently injured by cultivation. When any of the dwarf trees are planted, care must be taken that the union of the stock and cion is not placed beneath the surface of the soil, or else the cion will root, and being on its own roots, will lose its dwarfness.

APRICOTS

Apricots are usually budded upon seedling stocks or upon the Peach. The stones are treated like those of Peaches. They are budded about the first of September.

Some propagators hold that the Peach, being better adapted than the Apricot, to a range of soils, is, therefore, a more successful stock. Prof. Budd, however, advises the native Plums as the best stock, holding that they are superior to the Myrobalan or St. Julien stocks. For wet locations the Plum is especially useful.

CHERRIES

Fruit growers and nurserymen are, at present, having a controversy as to just which stock is the best for commercial Cherry culture. The Mahaleb and the Mazzard are the two sorts most used. According to Hedrick,* fruit growers hold that the Mazzard is the best stock for all orchard varieties; the nurserymen believe the Mahaleb better for the sour Cherries and really good for the sweet sorts as well. The Mazzard stock is the more expensive.

The Mazzard Cherry, *P. avium*, is the type from which has come the varieties of sweet Cherries. It is tall growing. The tree is not of the hardiest type but is a vigorous grower and is healthy, except for its susceptibility to attacks of the shot-hole fungus which makes it difficult to grow in the nursery. This stock is readily grown from seed.

The Mahaleb Cherry, *P. Mahaleb*, is a bush-like Cherry, with fine branches; the leaves are small. The fruits are green, turning yellow, and, when ripe, black; but they are hard, bitter and astrin-

*Hedrick, U. P. Cherries of New York.

gent. Mahaleb, therefore, differs widely from both the sweet and the sour Cherry. It is propagated mostly by seed, but may be increased by cuttings and suckers. It is much easier to get a good looking tree when Mahaleb is used because it is adapted to a great range of soils; more resistant to heat and cold; less particular about cultivation; will stand more pruning in the nursery; is less susceptible to aphis; is usually not so susceptible to the shot-hole fungus, and is more easily budded. Cherries on Mahaleb ripen their wood earlier and may be dug earlier; and they are hardier for the same reason. Sweet Cherries should be grown on Mazzard stock; the Mahaleb budded sorts are dwarf growing and varieties come into bearing earlier, although the size of Cherries is the same. Better unions are made on the Mazzard. The Mahaleb thrives on a greater variety of soils. The varieties on Mazzard are more productive and profitable than on Mahaleb.

Cherries are usually budded, but they may be successfully grafted upon seedling roots. When planted deep enough the cion takes root and the variety is then upon its own roots.

PEACHES

Much of our Peach stock is home grown. The pits or stones are gathered from the wild Peaches in the mountains of Tennessee and the Carolinas. The seeds collected at canneries are thought to produce short lived trees. Peach seed may be sown in flats of a sandy soil and exposed to the Winter frosts or they may be placed in pits, mere holes dug in the soil, in which the stones may be kept moist and to which the frost may enter. Peaches are usually budded, although some growers report success in grafting them.

In the South, Peaches are June budded but in the North budding is practiced in August or September. (See page 123.)

In selecting bud-wood, care must be exercised that mature buds are used; there are usually two or three immature buds at the ends of the branches. The current year's growth also has two sorts of buds, branch buds* and fruit buds; branch buds must be used as the fruit buds merely flower and are gone, while branch buds grow to make the top of the tree. The fruit buds are frequently found on each side of the branch bud; they may be broken off, as they are of no use. When only one bud is found in the axil of the leaf it is generally a branch bud.

*Branch buds are frequently called leaf buds but this is an incorrect term because each bud of this sort produces branches.

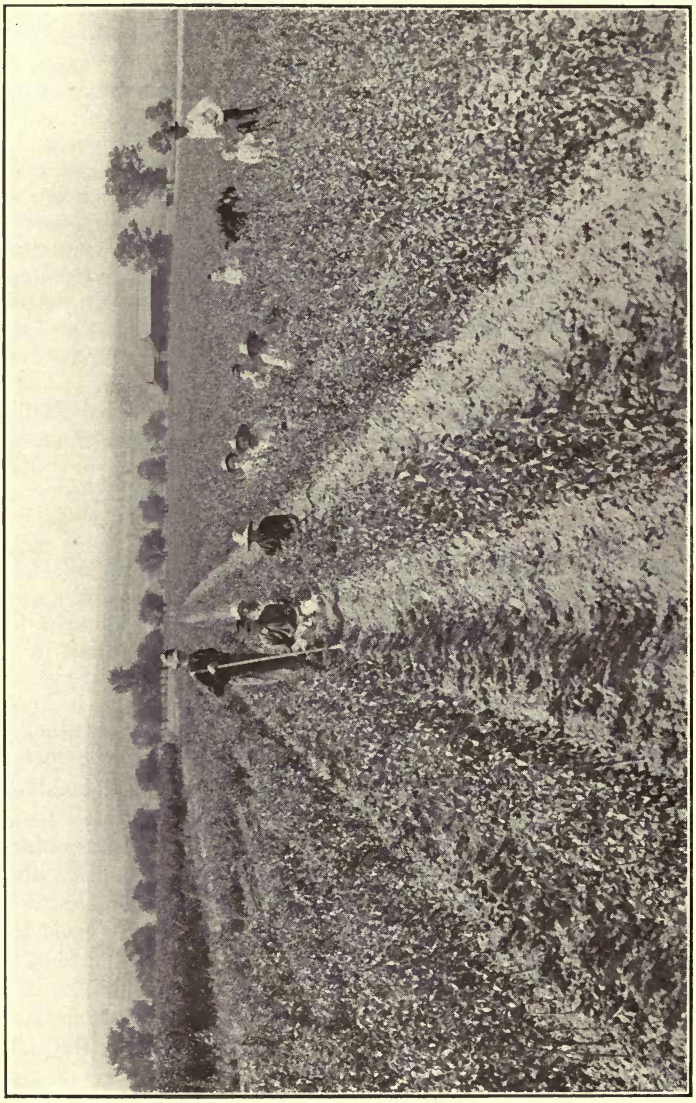


Fig. 80—Budding Cherries. One worker inserts the bud, another wraps it with raffia

PEARS

The stock used in grafting the Pear is mostly raised from seed gathered from the cider mills of France. This Pear is known as the Perry Pear. Often seedlings of the Kieffer are used for stocks, for these prove very blight resistant. Some stock is obtained from Japan in which case the stocks are seedlings of the Chinese or Japanese Sand Pear. Regarding the use of the latter Pear, Joseph Meehan writes:

"The Sand Pear and its offspring, the Le Conte, are found unsuitable for using as stocks for ordinary Pears, much as they may be desirable for the Kieffer, Garber and other kindred bloods. When the ordinary Pears are worked on them they grow nicely for a year or two, then almost cease growing and dwindle away. Whether this is true, too, in respect to the Kieffer itself, when its seeds are grown, is not so well attested. As it is a hybrid between the common Sand Pear and a common improved one, supposedly the Bartlett, its seedlings may be better suited for stocks than pure Sand Pear seedlings would be; still, those who have tried it do not appear to consider it as good for their purpose as the common French Pear stocks. Australian papers speak of the Kieffer seeds being used by the nurserymen of that country at the present time. What attracts those who use the seeds of the Sand Pear tribe, is, that the seedlings are just the thing for stocks for the Kieffer, this latter being popular everywhere as a profitable market Pear, and then the vigorous growth of these seedlings would fit them for stocks for all sorts of Pears could they be got to thrive on them."

Dwarf Pears. Dwarf Pears are obtained by budding or grafting on the Quince, the former method being preferred. Most Quince stock is obtained from Angers, France. The Pear seems to produce larger fruits when grafted on the Quince than it does on its own roots. Peculiarly enough, the Quince is not successfully grafted upon the Pear.

The Kieffer Pear should not be dwarfed; it usually outgrows the stock and results in a top-heavy tree.

Relative to the use of new Pear stocks *The Florists' Exchange* reports remarks by Dr. B. T. Galloway, who says that

"At the Arnold Arboretum the Calleryana Pear (*Pyrus Calleryana*), a native species from China and Japan, has proved quite hardy for the past twelve years. Seedlings from this tree have been tested as a grafting stock with considerable success. It resists fire

blight and, in comparison with the French stocks, offers a budding season that runs into September."

As might be expected, there appear to be several strains of the Calleryana Pear, and Mr. Galloway fears it will not easily be possible to obtain reliable seed from China, but efforts are being made to produce the desired material here.

The Chinese Water Pear (*Pyrus usuriensis*, cult. var.) is another stock of great promise. It should be mentioned that the wild Chinese Water Pear is less vigorous than the cultivated variety, which in some respects is equal to the Calleryana Pear as a stock. The Chinese Saw-Leaved Pear (*P. serrulata*) and the Chinese Birch-Leaved Pear (*P. betulæfolia*) are also of considerable promise.

Several nurserymen supplied with samples of these new stocks report excellent results, the average take being about 98 per cent; all record the unusual length of time that the stocks held their foliage compared with ordinary French and Japanese stocks.

PLUMS

Most growers prefer the Myrobalan Plum stock for general purposes. The native Plums are also used for American varieties and some nurserymen prefer the Peach for the Japanese sorts, when they are to be grown on sandy soils. The St. Julien is a variety propagated by the French nurserymen and frequently used as a stock for *P. domestica* and *P. insititia* when it can be obtained cheaply.

The Myrobalan is obtained from France and is raised from seed. Prof. Hedrick* mentions that its roots are apt to Winter-kill in the colder regions and in the warm sections of this country the plants sucker badly.

St. Julien stocks give trees longer lived, hardier, deeper feeding, less suckering and well adapted to changed soils. They are, however, difficult to bud and the young trees do not make the good growth that is made on the Myrobalan. Besides this, the young trees are rather susceptible to fungus attacks in the nursery rows.

The Peach as a stock proves successful on sandy or gravelly soil. The trees make a rapid growth, and bear when young. There is little tendency toward sprouting at the roots. The budding is easy and the nursery plants have a good appearance, besides being produced cheaply. Especially successful on the Peach are the Japanese or Triflora Plums. Prof. Hedrick says that the Lombard, the

*Hedrick, U. P. The Plums of New York.

Damsons, the Yellow Egg, the Washington, the Domestica and the Insititia varieties do not unite readily with the Peach.

Mariana stocks root readily from cuttings and give a good nursery appearance, but they are inclined to sucker.

The Americana stock is the only safe one for the coldest parts of this country. It suckers badly but produces a good root system. Americana stocks are not extensively employed by nurserymen because of their price and their unknown value.

Munsoniana seedlings are adapted for stocks when the orchard is planted in low, wet lands.

P. pumila is used as a stock for dwarfing Plums.

In top working Plums let the work be done early in the life of the tree. Later working will make slow and crooked growth. The Lombard has proved a successful stock for top working the Domestica varieties.

PEDIGREED STOCKS

There has been more or less discussion about the value of pedigreed fruit. The expression "pedigreed stock" is used by some nurserymen to mean that they guarantee their stock true to name, and that it has been propagated from bearing trees.

Other nurserymen mean by it that they are propagating their stock from superior, high yielding trees. If the latter is meant, there is little evidence to show that pedigreed stock is superior to ordinary stock. Prof. U. P. Hedrick writes regarding Plums:

"Buds in propagating are usually taken from nursery stock, a practice of decades, and there is no wearing out of varieties. Old varieties have lost none of the characters accredited to them a century, or several centuries, ago by pomological writers. Nor does it seem to matter, in respect to trueness to type, whether the buds be taken from a vigorous, young stripling, a mature tree in the heyday of life, or some struggling, lichen-covered ancient—all alike reproduce the variety. The hypothesis that fruit trees degenerate or, on the other hand, that they may be improved by bud-selection, finds no substantiation in this fruit."

Certain other authorities and, especially, nurserymen, like to believe that a good tree bearing good fruit yields buds and cions superior to those taken from an ordinary specimen tree. The reader must not take this statement to mean that cions of Bartlett Pears would not be superior to cions from a seedling tree or one of an inferior variety. It does mean that it is characteristic of a certain variety to manifest certain characters which are often greatly improved by culture, but the improvement due to superior culture is

not transmitted when the variety is propagated. Hedrick has an orchard of Rome Beauty Apples all propagated from cions from the same one tree. There is as much variation in this orchard as one would find in any orchard of one variety of fruit. Environment, not heredity, governs the yield, in this case.

Should one prefer further evidence of the uselessness of pedigree stock there are many experiments which tally with the above. The Missouri Experiment station carried on an experiment with ten generations of Strawberries. Runners were taken from the ten most productive plants of a variety and also from the ten least productive. From these plants runners were taken year after year, but the result was that there was no difference between the crops descended from the original high yielding plants and those descended from the lowest producer.

However, it is believed that it is unwise to select from the poorest plants because there may be in the variety some degeneration either in vigor or fertility. Selection is necessary to keep the variety up to its standard.

Bud Variations. This discussion is rather confusing when one reads of the great advances made in recent years in the selection of Oranges, Lemons and Grape Fruits. The case is entirely different. Many of the Citrus fruit trees are producing upon their branches bud variations, fruits with decidedly different characters than those normally exhibited by the crop of the tree upon which they grew. On one tree of Washington Navel Orange in California, nine types of fruit were found. Such behavior is known as "sporting." Hugo de Vries has pointed out that plants have definite periods for "sporting." Citrus fruits, Boston ferns, some Apples, and many flowers are now in this stage of "mutation" or change. These sports or bud variations are capable of being propagated. With most cases of Apples, Pears and Strawberries the differences in yield, color and size are due not to sporting or bud variation, but to the nurture of the tree. These differences are not propagated.

CHAPTER VI

IMPORTANT FLORISTS' PLANTS

ARAUCARIA—Seed—Cuttings—Grafting—ARDISIA—Cuttings—Seed—Air Layers—CARNATIONS—Cuttings—Sports—CHRYSANTHEMUMS—Propagation—Stock Plants—FERNS—Life History—Collecting Spores—Soil for Sowing—Sowing—Hybridizing—Division—Runners—Bulblets—Tip Layers—Tubers—Top Layers—LILIES—Easter Lily—From Seed—Madonna Lily—Seed—Scales—Stems—Bulb—Crossing—ORCHIDS—Division and Cuttings—Seed—PALMS Kentia — Phœnix — Areca — Cocos — Latania — Rhapis — Sabal—POINSETTIA—ROSES—Seed—Hardwood Cuttings—Softwood Cuttings of Outdoor Sorts—Indoor Cuttings of Commercial Roses—Summer Cuttings—Grafting and Budding—Rose Stocks—Manetti Canina — Carolina — Multiflora — Setigera — Rugosa — Grafted *vs.* Own Root Roses—Grafting to Increase Yield—Grafting Case—Preparation for Grafting—Grafting Operations—Budding Roses—Root Cuttings—Layers—Trenching Method—Seedling Inarch—Rapid Method of Increasing New Varieties—VIOLET—Improving Violet Crop.

ARAUCARIA—Norfolk Island Pine

Seed. *Araucaria excelsa* is a native of New Zealand. Seeds may be obtained there or possibly from import houses. Plants raised from seed are not satisfactory, since their lower branches are short, they are narrow at the base. Such plants, are, however, useful as stocks or as a source of cuttings.

Cuttings. Good cuttings may be taken from the ripened tops of the seedlings during Winter or early Spring. When cut back, a plant sends up a group of leaders which are also useful for cuttings. The cuttings should have several tiers of branches. C. Wm. Hess, in *The Florists' Exchange*, says that after the cuttings are taken they should be allowed to dry out for a day, then potted with sharp sand in the top half of the pot and good soil in the bottom. Place them in a propagating case, keeping them cool (60 degrees), but covering the frame. In three weeks the cuttings will have rooted and should then be repotted into light soil, kept growing for a time in the greenhouse and then placed in lath houses.

Cuttings from side shoots do not make symmetrical plants but they may be rooted, cut back and grown to furnish a source of leader cutting material.

Grafting. Hess writes: "Varieties such as *A. compacta*, *A. robusta* and *A. Baumannii* are grafted either on seedlings or on misshaped

plants of the species *A. excelsa*. The veneer graft is mostly used. In any case, graft low so that when the plant is repotted the union will come below the ground level and develop additional roots."

ARDISIA

Cuttings. The cuttings taken in late Winter will root at 65 degrees to 70 degrees without trouble in about four weeks. Some growers prefer cuttings because the plants branch near the soil. Of course, only a limited stock could be grown by this method.

Seed. The careful culture of Ardisias from seed is clearly described by H. D. D. in *The Florists' Exchange*. "Select at Christmas as many plants as you think will produce the amount of seed you wish to sow; pick out the plants with the best berries, and allow the latter to get fully ripe; this will be in January. Wash the seed to get it free of pulp and sow in flats, using a good light soil; put the flats in a house at 60 degrees to 65 degrees. By May or early June they should have two or three leaves; put them in one and three-quarter or two-inch pots and carry in a partially shaded house during Summer; by a partly shaded house I mean one with a strip of shading drawn down the glass, which allows plenty of light but breaks the force of the sun. They will probably need a shift to three-inch pots by September. Keep during the Winter at 50 degrees to 60 degrees and by Spring you will have excellent stock in three-inch pots. In May prepare a hotbed of manure in a deep frame. Try to have the manure turned once or twice so the heat will last as long as possible. Put four to five inches of good soil on top of the manure, as soon as the heat has subsided. When the thermometer drops to 80 degrees plant out the stock, cover with shaded sash, syringe often, to prevent them from getting dry, and watch the ventilation. Allow plenty of room in planting out, for they will grow fast and form the tiers that will produce the berries. By August or early September they will be fine stock, large enough to fill five and one-half or six-inch pots, and twelve to eighteen inches tall, that is, of fruiting size.

"Now comes the critical time. Have prepared another lot of manure, for another hotbed, in a deep frame, with shaded sash. See that you have plenty of headroom above the manure. Put in five or six inches of sawdust, shavings or spent hops in which to plunge the stock. Lift and pot the plants and put back in the new hotbed, plunging the pots. Look after the syringing with care. They will root and be safe in about two weeks. Get them inside by October 1; any light house kept at 50 degrees to 60 degrees will do now. They will flower in March or early April. During the flowering period cut down on the syringing. Give what air you can to keep the atmosphere dry; it is a great assistance in setting the fruit. During the Summer keep in a partly shaded house with plenty of air. By September or October give full sun, but don't raise the temperature—50 degrees to 55 degrees will do. All fruiting plants, as Oranges, Ardisias, Solanums, etc., mature their fruit far better in a moderate temperature than in a high one, since heat induces growth. You will have no trouble about the fruit coloring; they will be right for Christmas and stock will sell wholesale for from $24 to $36 per dozen.

"You may feel that a second hotbed is not necessary, but it is; it is the making of the plant. If after potting you put the plants in a

close, warm house they root slowly and drop many leaves, but the heat of the second hotbed starts root action quickly and establishes your plant. It is worth far more than it costs. If you wish smaller stock, plant out the smaller plants from the one and three-quarter-inch or two-inch pots and treat the same. In the Fall you will have nice stock with one tier of berries."

Air layers. The tops of plants which have become leggy as a result of dropping their lower leaves, can be rooted by air layering. An incision is made in the stem at the point where the roots are wanted. A ball of moss is tied around the stem and if placed in a propagating case the new plants will root in about six weeks. The stub of the old plant will send out shoots which can be used as cuttings.

CARNATIONS

Cuttings. Large Carnation growers reserve a certain number of plants which are not allowed to produce blooms, for it is from such plants as these that the best cuttings are obtained. The cuttings should be three to four inches long and are best removed from the plants by giving them a downward pull. Such a cutting will have several "hairs," or fibro-vascular bundles, at its base. Except for removing these hairs the cuttings are left untrimmed, unless too long, for, according to the best modern practice, the cutting should have as little cut surface as possible. Cuttings if taken from high up on the flowering stems are thought to give weak-stemmed plants, and if taken from the shaded bases of the plants the resulting plants are apt to be narrow-leaved and weak.

They should be rooted in a temperature of from 50 degrees to 55 degrees overhead, and 60 degrees to 65 degrees in the sand. Too high a temperature weakens the cuttings, and at 40 degrees they take a week longer to root. It usually requires 10 days to callus and from 18 to 21 days to root. The cuttings should be inserted very shallow in the sand. When rooted, pot into 2-inch pots and keep them close for several days, shading them and syringing carefully.

Carnation sports. Relative to Carnation sports, T. D. Hatfield, in the Report of the Massachusetts Horticultural Society for 1917, says: "A cutting or two may be obtained from the shoot that produces the sport, but in order to obtain a greater increase, resort must be had to leaf eyes. As, however, all sports are bud variations, still other sports are liable to occur. Propagation of any particular plant means the perpetuation of that plant in another individual. Every new plant raised in this way is a part of the original and just as old; it is the same plant. In connection with this fact it should be noted that when a Carnation gets ready to sport, it frequently sports in several places at the same time. So well is this fact known by judges that when a sport is put before them for certification the award, if considered, is generally withheld until it is found if the sport has appeared elsewhere."

CHRYSANTHEMUMS

Propagation. Chrysanthemum cuttings (see figs. 16A and 16B) may be rooted at temperatures of from 40 degrees up to 80 degrees, but 55 degrees is the proper one. If a bottom heat of from 5 degrees to 10 degrees can be supplied they will root a little more quickly. The

cuttings are taken any time between February and July, though April is the ideal month. The earlier they are taken the more shifts the plants will require in order that they shall not become woody. Late propagation gives dwarf plants. The cuttings are treated as soft wood cuttings and should be potted as soon as roots start. The plants may be set deeply in the pots in order that they may not appear spindling. Use little or no manure at this time.

Stock plants. After flowering, the blooming stems are cut down and the plants are shifted to an out-of-the-way bench and planted closer together where they may be kept cool (40 degrees), but also in good condition until cuttings are required. The plants should not be placed under the benches or in any place where they will not receive good light nor have a good circulation of air. At the beginning of March more heat and moisture should be supplied.

FERNS

Life history. Ferns bear spores, flowering plants produce seeds. Fern spores are not embryo plants, but single cells. When placed in a favorable soil for growth, they produce small, heart-shaped plants, usually about the size of the end of a lead pencil. This young Fern stage is known as the *prothallus* (see fig. 81[3]). Male and female organs are produced on this prothallus.

When the male elements are ripe, they lash themselves about with their tiny tails, and enter the female portions of the plant. As soon as the union has taken place, a tiny frond is produced which gradually develops roots and other fronds until it becomes a mature fern.

Upon maturing, a definite portion of the frond develops spore-bearing apparatus. These are known as *spore cases* or *sporangia* (see figs. 82[1] and 82[2]). They become miniature sling-shots when ripe and, bursting, scatter the spores a great distance. Most Ferns have these sporangia associated together in small clumps, called *sori*, which appear as brown spots on the fronds (see figs. 81[1], 81[2], 82[3], 82[4], 82[5] and 82[6]).

In many Ferns, certain fronds only produce the spores; these are known as fertile fronds and usually differ in form from the sterile fronds.

In the *Osmunda regalis*, or Royal Fern, the tips of the fronds alone are so changed as to be devoted to spore bearing (see fig. 81[2]). Certain of the Adiantums, or Maidenhair Ferns, and many of the Boston Fern ports have transformed their fronds to such an extent that no spore areas are found, all fronds being sterile.

Fern Propagation by Spores

Collecting. As soon as the Fern fronds are seen to be maturing their powdery spores, the whole frond should be picked and placed in a paper bag to save them. The ripening stage can best be ascertained by the use of a hand-lens. They should remain in the bag for several weeks before sowing.

Soil for Fern spores. The proper soil for sowing spores is one composed of leafmold, sand and well decayed sod loam. The sand will furnish good drainage. The soil must be carefully sifted through a fine sieve, and sterilized by having boiling water poured through it, or by being baked.

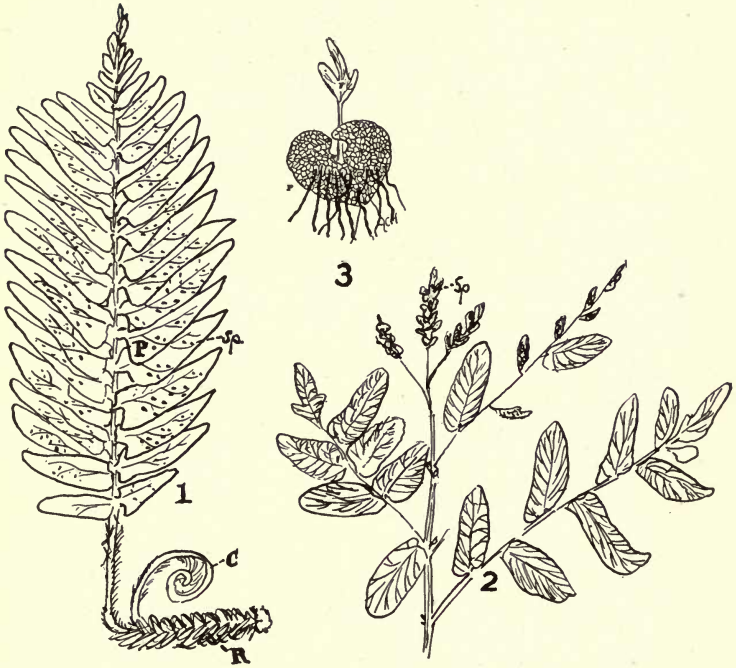


Fig. 81. Ferns. 1, A Fern plant bearing a mature and an unfolding frond (c). Each division of the frond (or leaf) is known as a pinna (plural, pinnæ) (P). The pinnæ are covered with dot-like masses, or spore cases (sp). The underground stem of a Fern is known as a rhizome or root-stock (R). 2, A portion of a frond of *Osmunda regalis*, the Royal Fern; in this case certain pinnæ are much reduced in size (sp.) and are the only ones which bear the spores. 3, A Fern prothallus. This is the sexual stage and produces the male and female organs which in uniting give rise to the growth of the mature forms. This prothallus has started to produce a frond (See page 146)

Sowing Fern spores. The pots used should be thoroughly sterilized by burning. When large quantities of Ferns are grown the spores are sown in flats or shallow boxes, although usually seed pans will be large enough. Plenty of drainage (broken flower pots) is always used in the bottom of the flats. The soil is now carefully placed in the flat and lightly pressed to a perfect level. If the surface is not absolutely level the lower portions of the flat will become damp and sour. Water the soil with a fine rose spray, or submerge the flat in water so that there will be sub-irrigation. Scatter the spores evenly over the surface after the soil has lost its first appearance of wetness, and cover with a pane of glass and a newspaper. When the spores have germinated the glass should be raised to give ventilation. Gradually more air should be given until finally the glass may be removed.

When the Ferns have grown several leaves they should be transplanted on the point of a knife into flats, using a soil consisting of a mixture of leafmold and sand.

Hybridizing Ferns. It is when the Ferns have grown to resemble a small round leaf that they have reached the prothallus stage or sexual period (see fig. 81[3]). They will now hybridize. If hybrids are not wanted, keep the various flats away from each other, otherwise a mixed lot of stock will result. Ferns do not mix when in the large, frond-bearing stage. It is not the spores of the fronds which do the crossing.

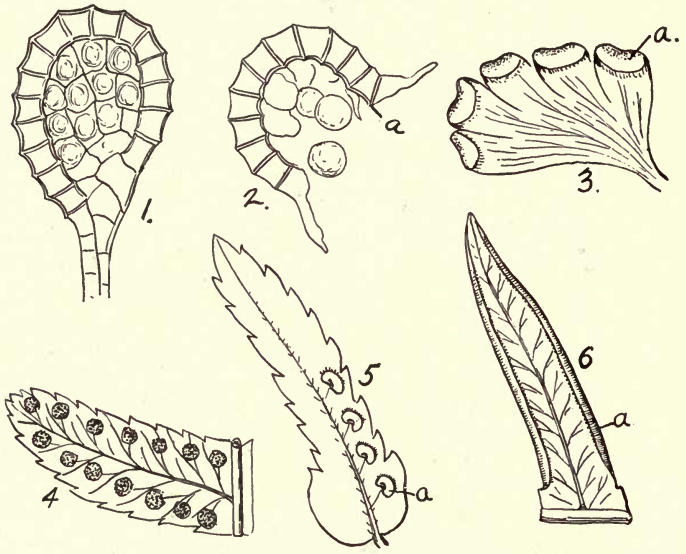


Fig. 82. Ferns. 1, A microscopic view of a spore case before it has burst. 2, The spore case has ripened and is scattering its spores. 3, The spore areas of *Adiantum.* Note that the tips of the pinnæ are folded back and it is under the margins that the spore cases are produced. 4, The spore cases form huge clusters in *Polypodium.* 5, In *Dryopteris* the spore cases are kidney-shaped. 6, Each pinna at the tips of certain fronds of *Pteris* has the edged rolled back; under these the spore cases are borne

(See page 146)

When hybridization is desired sow the various sorts of spores together, so that when the sexual stage develops, the plants may cross one with another.

Propagation by division. Many Ferns produce prominent rhizomes which may be cut into small pieces and placed in the propagating bench, with a little bottom heat, to root. When rooted they should be potted into small pots, using a loose soil. A decayed sod loam and leafmold mixture will be best. A few of the Ferns so propagated are: *Adiantum; Davallia,* the Rabbit's Foot Fern; *Dicksonia; Lygodium,* the Climbing Fern; *Nephrolepis,* the Boston Fern allies; *Osmunda; Phlebodium; Polypodium;* and *Niphobolus,* also called *Cyclophorus.*

Adiantums, especially *A. Farleyense* and *A. Croweanum*, which produce no spores, are frequently propagated by division early in the year; the plants are removed from the pots and the mass of rhizomes is broken apart even down to one or two eyes. The small pieces are placed in sphagnum moss at a temperature of 65 degrees in a confined atmosphere to produce roots. Later they are potted into thumb pots. The large plant may merely be cut in two or three clumps, but the method mentioned will give a great increase of stock which will soon attain good size. It is advisable to remove a quantity of the old soil and the dead and dried rhizomes.

Propagation by runners. One of the commonest methods of propagating the Boston Fern allies is by runners. Long string-like growths occur on all sides of the main crown. Boston Ferns intended for sale may be placed in the empty greenhouse benches early in Summer. With a little care the Ferns will be surrounded by young plants which grow quickly. In August many of these plants may be potted for Autumn sales. Cut back the fronds to four or five inches in potting. It is best not to carry over the stock plants for more than a year.

Fig. 83. Asplenium. Certain of the fronds may be noted in the cut which show the development of small plantlets on the fronds. Note especially the lower fronds of the plant. (See page 150)

In the propagating of the numerous sports of the Boston Fern, should a new one appear, and if a runner starts at its base, it will often carry the characteristics of the frond above it; otherwise the rhizome may be divided, in which case those frouds not having the desired characteristics should be removed.

Propagation by bulblets or plantlets. It is interesting to note that some Ferns produce, upon their fronds, small bulblets which even start to grow while attached to the parent leaf (see fig. 83). The fronds of such Ferns should be placed on the sand, or in a flat of leafmold, so that the growth from the bulblets may be encouraged.

Asplenium bulbiferum, *Gymnogramma*, *Cystopteris bulbiferum* and *Polystichum angulare var. prolifera* produce bulblets. *Pteris* (*Doryopteris*) *palmata* produces little plantlets at the base of the frond.

Propagation by tip layers. In propagating *Camptosorus rhizophyllus* the Walking Fern; *Asplenium ebonoides* and *A. pinnatifidum*; *Adiantum caudatum* and *A. Edgworthi*, the tips of the fronds should be pegged down to the soil, where they take root readily.

Propagation by tubers. *Nephrolepis exaltata var. tuberosa* produces beneath the soil tubers which may be used to increase the plants.

Propagation by top layers. The tree Ferns, such as *Alsophila* and *Cyathea*, may be propagated by Chinese layers as described on page 99 (see fig. 46).

LILIES

Lily propagation. The various Lilies and especially Easter Lilies (forms of *Lilium longiflorum*) have been propagated for many years by the rooting of bulb scales and by the natural division of the bulbs, but recently a method of raising Easter Lilies from seed has been strongly advocated as a method by which certain diseases may be avoided.

With rare or unusual species of bulbs there is still an advantage in propagating by bulb scales. The scales are treated like cuttings and are placed in benches of sand or a sandy loam at a temperature between 45 degrees and 60 degrees, when small bulbels will be produced. Some tender sorts need bottom heat.

Division is the commonest method, as it is the natural tendency of most Lily bulbs to divide after flowering.

Easter Lilies from seeds. Geo. W. Oliver, of the United States Department of Agriculture, who has conducted many experiments upon raising Easter Lilies from seed, writes as follows:

"Seed of the Easter Lily is not offered for sale by any of the seedsmen so far as known, therefore it must be produced as wanted by the grower. This is not attended by any serious difficulty, provided the grower knows what to do at the proper time. The plants selected as seed bearers should be strong and absolutely free from disease. This condition will be indicated by the absence of discoloration of any kind on the foliage.

"To produce seeds of the best quality the mother bulbs should be planted out in beds, where they are less liable to be neglected in watering. It is preferable not to use the pollen on the stigmas of the same plant. Several hundred good seeds may be secured from each plant. All of the flowers on a plant will set seeds if the stigmas are pollinated,

Fig. 84.—Easter Lily grown from seed. The photograph was taken seventeen month from seed sowing

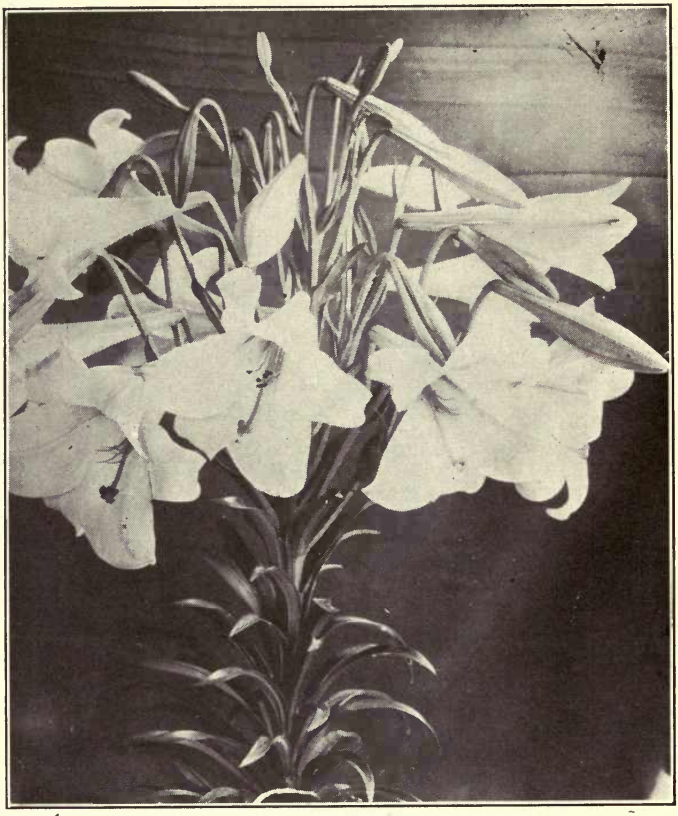


Fig. 85.—Seedling Easter Lily. This seedling Lily is in its second year and has thirty-six buds and flowers. It was raised by Geo. W. Oliver

but three or four capsules to a good sized plant will give larger and better filled seed capsules and make stronger seedlings.

"The seed should be sown in boxes during August. Allow three leaves to develop before putting the seedlings in two-inch pots then shift to three-inch when they have five or more leaves. By the middle of February they should be put in five-inch pots and should be placed in an open frame as soon as the weather permits. Those which show signs of flowering in May should be thrown out. During August the strong plants should be in seven-inch pots.

"When cool weather sets in, the sashes should be put on, giving air as the plants require it. These plants should be at their best by Easter.*

* The United States Department of Agriculture has obtained many seedlings flowering in 15 to 18 months from seed.

If everything goes well most of the plants should give from 25 to over 30 flowers per plant. (See figs. 84 and 85.) The highest number we have secured on one plant was 37. If liquid manure be given occasionally the flowers will be much larger than those produced by the foreign-grown seedling bulbs.

"The results secured by the use of American field-grown bulbs of the Easter Lily are not always as satisfactory as they should be. It has been the practice of bulb growers to burn the candle at both ends; that is, to dispose of the flowers and, later on, the bulbs. In order that the field-grown flowers may command good prices it is necessary to cut a considerable length of stem and number of leaves along with the flowers. The consequence is that the bulbs do not mature as well as if the leaves were left on the plant until the maturity of the bulb, and the result of this practice is always unsatisfactory.

"If the seedling method is given a fair trial the Lily will pay handsomely. I understand the seedling bulbs grown in Japan are always disbudded to give strength to the bulb. But so far as I have seen, this is not always the case in Bermuda."

Dr. David Griffiths, also of the Department of Agriculture, has accomplished a great deal in the production of Easter Lilies, and has published several excellent discussions of his methods. It might be of interest to add to the notes of Mr. Oliver a summary of Dr. Griffith's results as published in *The Florists' Exchange* of Feb. 28, 1920. His 17 points are:

1. Pollinations at Easter will give us ripe seed in early June.
2. Seed planted in early August will be ready to pot into 2's in November, into 3's in January, and into 4's in March or April.
3. If well handled, such a progeny will show scattering flowers in June.
4. All the progeny, whether the plants have flowered or not, can be dried off for four to six weeks in August to September, and 10 per cent to 25 per cent of the largest can be forced for the following Easter.
5. Instead of planting the seed in August it may be sown the 1st of January, when it will germinate in about one-half the time.
6. The seedlings will then be ready to pot off in March.
7. As soon as danger of frost is by these can be put in the open ground 6 inches apart each way.
8. If suitable fertility and moisture are furnished scattering blossoms will appear in July and continue until frost.*
9. The plants which have not blossomed can be potted from the field for Winter forcing.
10. If not handled in this way the seedlings may be dug and dried off in early October and planted out of doors again November 1, with a good dressing of well-rotted manure after the ground freezes.
11. These bulbs (from 10) should then be dug the following August or September and potted up for Winter forcing, the smallest and the stem bulblets being held until November to be planted out again to continue the propagation.

* Here, it will be seen, are some Lilies which have bloomed in seven months. "Would it not be possible," asks Dr. Griffiths, "to produce an early flowered strain which might be sown in September in frames, to germinate in April and be handled like Onion seedlings? After growing during Summer the seedlings could be potted and forced for Easter, being then only 11 months from the germination of the seed."

12. We do not yet know whether all seedlings put out in the Spring will survive the first Winter without being reset, though some of them surely will. We will know more about that next Spring.*

13. Crosses of *Harrisii giganteum*, *Formosum giganteum*, and *multiflorum giganteum*, have all produced good stocks, as has also *Formosum Harrisii*, and even selfed plants have given good results.

14. Push the stock along all the time with plenty of fertility and good moisture conditions.

15. The seedlings will be uneven, but then, so are imported stocks.

16. If the grower will select the type of plant that suits him best from his batch of seedlings he can very soon work up a stock from a single bulb by vegetative reproduction, but mass selection is feasible.

17. Bulbs set 6 inches to 8 inches deep in suitable soil will give a propagation of 6 to 12 stem bulblets. Normally, the setting should be 4 inches to the top of the bulb. The object of deeper planting is to increase the propagation.

Propagating the Madonna Lily (*L. candidum*)

Dr. Griffiths, in *The Flower Grower*, for December, 1920, writes on this subject as follows:

"This really is one of the easiest of Lilies to grow. It is on a par with *Lilium longiflorum*, *L. myriophyllum*, and *L. tigrinum*. It is likewise most readily propagated by several methods.

"*Seed.* It is seldom that seed is produced, but when a set is obtained germination is readily accomplished. I have gotten seed but once, but occasionally hear from people who do get it. It is suggested to those who have clumps of this Lily, that they hand-pollinate with its own pollen and with that of some other species. Seedling strains may give us greater vigor than the stocks which have been propagated so long vegetatively.

"*Scales.* This is the method almost universally employed in increasing the stock of this species. On Puget Sound we scale the bulbs usually in July, shortly after the plants have flowered, and plant the scales in beds as we do Tulips, one or two to the inch in rows six inches apart, where they remain two years undisturbed. They are covered two inches deep. The resulting bulbs begin to flower the third year.

"If one has a greenhouse in any region where the temperatures run high in Summer, the propagation can be much accelerated. We have been able to get the old scales all transferred into bulblets between June 20 and October 1, by keeping them on moist sand under the benches of the greenhouse. The space under the benches was closed in by burlap. The scales were kept in precisely the same atmospheric condition as required for the propagation of Hyacinths except that they were laid on the sand under the benches instead of on wire trays.

* Dr. Griffiths comments on this point in *The Florists' Exchange* of March 12, 1921, as follows: "The grower who, instead of forcing these seedlings into flower during the Winter, wishes to get up stocks to be handled vegetatively, *i. e.*, wishes to grow bulbs under out of door conditions, has his choice of at least two methods of procedure. He can mulch (about Nov. 1, in the climate of Washington, D. C.), heavily with some coarse litter such as marsh hay or cornstalks, which is to be gradually removed in the Spring. The plants will lose their tops, but this does not seem to matter. The other method is to dig all the seedlings Nov. 1, cut the tops off, and the roots might as well be cut off too. The stocks may then be reset immediately four inches deep to the top of the bulb and mulched lightly with strawy or fine decomposed manure, which is to be left on the beds."

It will be readily seen that this trick is a decided advantage, inasmuch as it puts one a year ahead in the production of these bulbs from scales. If planted in the open ground it takes a year to get the scales used up. In the vicinity of Washington, D. C., the bulbs are mature in late June and can then be scaled. By late September the scales are used up and the bulblets start to root and form top growth. They can then be planted one and one-half to two inches deep in the open ground.

"*Stems.* There are few crops in which the waste product can be used for propagation as it can in this Lily. As is well known, the foliage of this Lily commonly dies shortly after the flowers have faded. If the flower stem is cut within, say, a foot of the ground, as is common in marketing the flower, the remainder of the stem can be used in propagation. With a twist and sharp pull sidewise, the base of the stem can be easily pulled out of the bulb, with apparently no injury to the latter. These old stem bases can then be layered in sand and in four months will produce six to fifteen bulblets, some of which may flower the second year and many the third.

"There are various ways of handling these stems. We have had good success with them in the same chamber in which Hyacinths were incubated, *i. e.*, under benches in the greenhouse as described above. We have also had good propagation in a month or six weeks' longer time when the stem bases were layered in sand, where the conditions were not altogether dry but still not moist enough for plant growth.

"The method of propagation from the stems is to be recommended as quick, efficient and inexpensive. Its application, furthermore, is not confined to this Lily. It has a very wide application in the genus, as has also the scales method.

"In the Puget Sound region it is the universal custom to jerk the stems out of the bulbs and clean up the beds as soon as the flowers have faded. There is apparently no evil effect from the practice. Whether it would be safe where July and August are wet months is not known.

"*Bulb.* There is a propagation occurring naturally by the splitting up of the old bulb, but in this species it is a rather slow method of increase, for the bulbs get very large before they split, provided conditions are suitable for the best development of the species."

Crossing Lilies

Prof. E. A. White, in *The Florists' Exchange* of July 12, 1919, writes that in the course of work carried on by C. L. Chien few Lilies set seed well after self-fertilization. In 38 crosses made at Cornell University, seedlings were obtained from crosses between 10 species.

The actual crossing process is described by Professor White as follows:

"As the buds began to develop in March one of the strongest was selected for blooming and the others removed. This was to give vigor to the parent flowers. After the flowers were well opened and the stigmas had become receptive they were cross-pollinated. Pollination in Lilies is comparatively easy for the essential organs, *i. e.*, stamens and pistils, are large and the pollen is abundant.

"It was found necessary to hand-pollinate the pistils in order to insure the best development of seeds. Nature seems to endeavor to prevent self-fertilization in Lilies, for in most species the pistil is much longer than the stamens and the pollen is too heavy to be blown to the

stigma. In these flowers which were self-pollinated by hand, it was found that while the ovary might develop, the seeds produced were very few with a weak germination and the seedlings produced sickly plants.

"When the flower bud was about ready to open it was emasculated (*i. e.*, the stamens were removed) and as soon as the pistil was receptive, which condition was indicated by the appearance of a sticky material on the surface of the stigma, the desired pollen was applied. Lilies are seldom pollinated by insects in greenhouses, but as a precautionary measure, the flowers were covered with paper sacks for a few days before the stigmas became receptive and after being cross-pollinated.

"After pollination the flowers soon withered and the ovary increased in size rapidly. During the Spring the seed pods matured in about two months."

ORCHIDS

Orchids were not extensively propagated before Quarantine 37 was imposed, but were collected from the wild. They may, however, be increased by division, cuttings and seeds. All Orchids are propagated at the beginning of their growing seasons.

Division and cuttings. The rarer sorts bearing pseudo-bulbs, such as *Cattleya*, *Odontoglossum*, *Cœlogyne*, may be propagated by division in which the rhizome is cut partially through. Two or three pseudo-bulbs are best left beyond the growing point. The cut will cause the forcing of an adventitious bud upon the older wood. The old portion is then removed and potted separately. With *Calanthe Veitchii* the old bulbs may be removed when potting in Spring, and placed in pans of sphagnum moss until they start to grow, when they may be potted.

Dendrobium canes may be cut into four- to five-inch lengths or the whole cane may be laid on wet sphagnum. New growths will often start from the eyes. *Aerides* and *Vanda* are propagated by cuttings of the upper portion of the stem, which is about a foot long and supplied with roots. The old stems will usually produce shoots readily. *Cypripedium* plants are best divided between old growths and potted separately, leaving an older growth with each lead. Provide abundant moisture in starting them. *Masdevallia* and allied genera are propagated like *Cypripedium*.

Orchids from seed. The seeds of Orchids are very fine and dust-like. Some pods contain over 500,000 seeds. Great care is necessary in growing them successfully. Several years ago it was discovered that the tiny seedlings only grow when a certain fungus is present. This fungus is found in the pots or baskets of most Orchids, so that it is not difficult to obtain, and if a plant is kept in the seedling frame, the fungus usually spreads to the seedlings.* It takes patience to grow Orchids from seed because few of them bloom in less than five years; it may even require ten years. John E. Lager,† a successful Orchid specialist, describes the sowing of Cattleya seeds as follows:

"*Cattleyas*, as, like most other Orchids, are unable to fertilize themselves, hence the fertilization must be accomplished by insects. The seed pods should be left on the plants until well ripened; when they

* Refer to Stand. Cyclop. of Hort. under Orchids for full account of seedlings.
† Lager, John E. The Seeding of Cattleyas, *Florists' Exchange*, Nov. 25, 1916, p. 1226

Fig. 86. Rhizome of Dendrobium. Each year the *Dendrobium* sends up a food-storage stem, or pseudo-bulb, the growth arising from the scales at the base of the parent stem. The leaves have fallen from the stem at the right; the center stem may bloom, and the stem at the left is ready to produce leaf growth.

show signs of splitting open, tie a string or piece of raffia around them to prevent water from getting inside. Leave the pods on the plants until they begin to crack open, when they should be removed from the plant, placed in a paper bag and stored in a dry place to prevent loss of seed until time to sow.

"One way of sowing the seed is to sprinkle it on the surface of the compost in which the plants are growing. Personally, from observations taken at several places where Orchids are successfully raised from seed, I believe it is better to use muslin or calico; that is, take a piece of this material and place in it a ball of sphagnum and press the whole into, say a 3½-inch or 4-inch pot, in such a way that the highest part is in the center of the pot, sloping gradually toward the edges, and pressed in firmly. After this is done water thoroughly and allow to dry, after which the seed may be distributed over the surface of the goods.

"If a propagating case is available it may be used if the temperature does not exceed 75 degrees; otherwise place a piece of glass over the pot, put the pot on an inverted pot, and the latter in a saucer of water to prevent insects from attacking the seed. Watering should at first be done only by immersing the pot up to within an inch of the rim, as any overhead watering would wash away the seed. Later on spraying with a very fine sprayer will be all right. Air must also be admitted carefully. After germinating the little seedlings should not be allowed to get dry. When germination takes place it may be noted by the fact that the seed takes on a green apearance, after which it develops into green bodies showing a growing point; then roots appear.

"The tiny plants are now ready to be pricked off into pots, several to a pot. These should be prepared carefully, with ample drainage of broken pots and charcoal, over which good Osmunda fiber should be placed, the top being finished off with the same material mixed with a sprinkling of live sphagnum and cut up finely. Insert the little plants in holes a quarter of an inch apart and spray the whole with a fine sprayer to settle the plants in position. Great care should now be exercised to prevent them from damping-off, through excessive moisture or too close an atmosphere. A constant, genial moisture and the admittance of air in moderation—in short, constant attention is what is now required. Later on, when the little plants begin to send forth their leaves, they may be transferred to small one-inch pots, a plant being put in each."

PALMS

Among the many plants excluded by Quarantine No. 37 are Palms Most of the stock of Palms sold in the United States formerly cam from Belgium, but a few Palms have been grown in California for som years.

Kentia (*Howea*). The two commoner Palms used by the commercial florist are the Kentias, *K. Forsteriana* and *K. Belmoreana.* These are propagated to the extent of a half million seeds per year in America alone. The seeds come from Lord Howe's Island, in the South Pacific, and are often a long time in transit. They sometimes heat badly in the cases and suffer some injury. *The Florists' Review* for June 5, 1919, says of them:

"Kentia seeds usually arrive in this country in the late Summer or in the Autumn and are sown in various ways, according to the quantities the grower may have to handle. Growers having large lots stratify them in benches, or sometimes even under the benches, using a light and open soil, such as peat or sandy loam, for the germinating medium. If the seeds are sown on a bench, about two inches of soil is first put in; then the seeds are sown as thickly as they will go in a single layer, covered with soil to the depth of one inch and are well watered in.

Fig. 87. Phœnix Rœbelenii

"Small lots of Kentia seeds may be sown in trays, or in pans. Afterward the soil is kept moist at all times and a night temperature of 60 to 65 degrees at least is maintained. These seeds germinate quite irregularly and it is best to save and replant any that do not come up with the first growth. Some seeds have been known to come up after a period of three or four years, while some come through in two months.

"When the Kentia seedlings have expanded the first leaf, it is time to pot them off into 2-inch or 2¼-inch pots. They should then be placed in a shaded house, with a temperature of not less than 60 degrees, and regularly syringed in bright weather in order to keep down the insects."

It is often found best to resow the seeds which have not germinated and which have been disturbed by lifting those which have grown.

Phœnix or Date Palm

Phœnix seed comes principally from Siam, *P. Rœbelenii* being the principal species used. If fresh seeds are obtainable they will germinate easily if given an abundance of moisture and a regular temperature approaching 80 degrees. The seedlings are small and it requires a year to grow a 3-inch pot plant.

Areca (*Chrysalidocar pus*)

Areca lutescens is the common graceful Palm with yellow stems. It will not stand as rough handling as the Kentia. The seeds come from Brazil.

Cocos (Cocoanut Palm)

Cocos Weddelliana is the species most commonly propagated to provide small plants for the fern dish, or to grow on. Fifty per cent of the seed can be counted upon to grow. M. L. Leopold thus describes the growing of Cocos from seed in *The Florists' Exchange:*

"Some growers fill flats with a mixture of soil and peat, put the seeds on top of the soil and cover with moss and leave them until they begin to geminate. There is where the trouble begins. The roots of *Cocos Weddelliana* are very brittle and the smallest negligence while uncovering the seeds to examine whether they have germinated will break off the roots that have just started to show. By several such examinations a large number of the seeds are destroyed. The remainder of the germinated seeds which have not been destroyed are put into pots in too heavy soil. The result is that a large number of these die off before they are able to push through.

"When the seeds of *Cocos Weddelliana* arrive, pick out a house in which the pipes are placed in the middle of the benches and where no water stands under the benches. Rake the ground well after liming it; get new, or at least well washed, 2-inch pots. Cover the bottom of the pots with a piece of slate or anything that will cover the hole. Fill the pot half way with pure sandy peat, then put in two seeds, cover with peat, and set the pot on the prepared bench.

"When the potting is done take good care to keep the peat always moist, but not too wet. In six weeks, if proper care has been taken, the seedlings will come through. Give as little top watering now as possible else the small plants will rot. Just spray occasionally. The main point is to keep the ground wet enough for the plants to be able to draw moisture from the bottom. Such care should be taken until the first part of June, then the plants are lifted and plunged in fresh ashes on a center table.

"A few plants will probably have their roots through the bottom of the pots. Take care that the roots do not get broken off, but cut them off with a sharp knife.

"Till the middle of September the plants should remain in the peat. Give sharp syringings, but avoid heavy waterings. Every other week give a light dusting with sulphur to keep the plants free from scale."

Latania (Fan Palm)

Latania seed is cheap, easy to procure and germinates quickly, but the plants take up more room than is profitable. The seeds may be sown like those of Kentias. The roots are easily broken, so pot them carefully.

Rhapis

Rhapis flabelliformis is propagated principally by division of the plants.

Sabal (Palmetto)

The seeds of the Palmetto are very hard and will not germinate quickly unless kept moist at all times. They also require a high temperature for germination.

POINSETTIAS

The Poinsettia produces an abundance of milky juice; plants with this characteristic are more difficult to root than some others. Two sorts of cuttings may be made of Poinsettias, hardwood and softwood.

In making the hard or dormant wood cuttings place the plants, after flowering, under the bench of a warm house and gradually withhold water so as to allow them to ripen. During March cut the canes into four-inch lengths, and after the milk has stopped flowing, wash the cuttings in warm water and dip them in powdered charcoal Place in a moderately dry propagating bench at a temperature of 65 degrees. As soon as roots have started, pot the cuttings in thumb pots.

For making softwood cuttings start the plants in April. Shake the soil from the roots of the old plants and pot in smaller pots. The storage roots will soon cause the growth of good cuttings, which, when several inches long are taken with a heel. Drop the cuttings as soon as made in a pail of cold water and leave them there for a half hour. The bleeding will stop and the cuttings will remain fresh and will not wilt. They may be rooted in the sand bench or potted immediately and placed in a close propagating case. Cuttings may be taken all Spring and Summer; the earlier cuttings will give the taller plants.

ROSES

Seed. The various botanical species of Roses may be propagated by seed because they breed true. Horticultural varieties must be propagated by some other method.

Collect the seeds when ripe and pound them from the fruits; allow the mass to ferment; then wash it and separate out the seeds. They are sown immediately or else stratified. Cover the seed with sand instead of soil. *Rosa blanda, R. canina, R. japonica, R. carolina, R. cinnamomea, R. hispida, R. Hugonis, R. humilis, R. lucida, R. lutea, R. multiflora, R. nitida, R. pisocarpa, R. rubiginosa, R. rubrifolia, R. rugosa, R. setigera, R. spinosissima* and *R. Wichuraiana* especially are grown from seed.

Hard wood cuttings. Most Briars, Climbers and Polyanthas may be propagated by hard wood cuttings. The canes should be cut into 5 inch to 6 inch lengths and buried in sand during Winter and set out in Spring. (See page 73.)

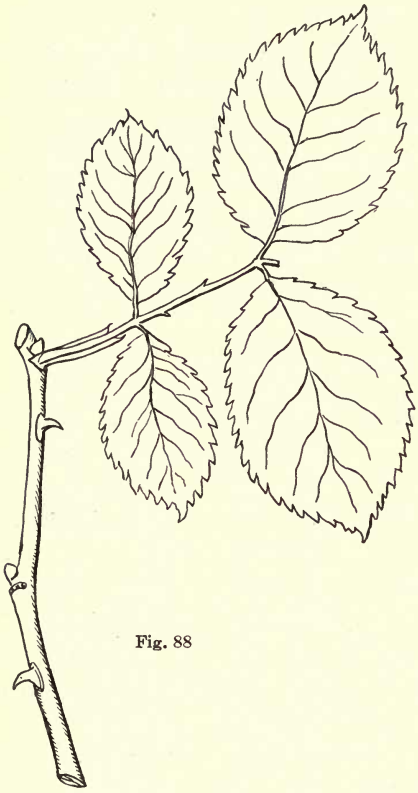


Fig. 88

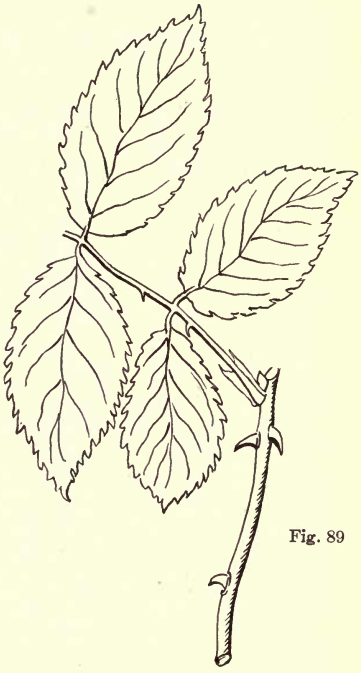


Fig. 89

Fig. 88. A three-eye Rose cutting. The cut at the base has been made through an eye. One eye is placed in the sand.
Fig. 89. A two-eye Rose cutting. The leaf area has been reduced and the cut at the base is through an eye.

Soft wood cuttings of outdoor Roses. Pot up such Roses as are needed for propagation, using one- or two-year-old plants. Store away in coldframes. About the holidays the plants should be brought into the houses. When the growth is about to bloom, just when the buds show color, the flowering stems may be cut into one- or two-eye cuttings. These cuttings should then be placed in sand to root. Pot in two-inch pots as soon as roots are a half inch long. The large potted plants will furnish cutting material for the whole Winter and Spring.

This method is used especially in propagating Teas, Hybrid Teas, Hybrid Perpetuals, Climbers, Polyanthas and others not coming true to seed.

Indoor cuttings of commercial Roses. Cuttings of greenhouse Roses are taken from the middle to the end of January. Most growers prefer to use cuttings which have been so made that the cut at the base is through an eye, two other eyes being left on the cutting. (See fig. 88.) It is, however, admissible to make cuttings with only one eye when stock is scarce, but the plants do not develop so rapidly. (See fig. 89.) Many growers in cutting the crop for sale allow longer stubs than necessary; these stubs are later removed for propagating wood. In all cases, use wood with live thorns and healthy leaves.

Many plants produce blind wood or non-flowering wood, which seems to be just as good for use in propagation as the flowering wood. Some growers claim that short blind wood is good because the plants grown from such cuttings make strong breaks from the base of the plants.

The best temperature for rooting Roses is 55 degrees for the overhead and 60 degrees for the sand. Care should be taken in watering so that too cold water is not used because black spot is apt to result.

Roses root in about 30 days, depending upon the variety and the temperature. When the roots are about a half inch long the cuttings are potted. The deeper 2½-inch Rose pot is preferred to the standard pot. A little manure may be added to the first potting soil

Summer cuttings Cuttings may be taken from plants grown indoors during late Spring, Summer or early Autumn and placed in warm beds until rooted, when they are potted and grown to proper size under glass. They are hardened off and go through the Winter in dormant or semi-dormant condition. The Teas and Hybrid Teas should not be allowed to freeze or become perfectly dried out. "The claim made for it (this method) is that all unnaturalness of forcing out of growing season is eliminated, both in production of wood and growth of plant."* Many varieties as, for example, Frau Karl Druschki, are easy to root by this method, although difficult when cuttings are taken in Winter. Rambler cuttings taken with a heel root readily. *R. Hugonis* also is successfully propagated by this method.

Grafting and Budding Roses

Roses are often grafted because some of the varieties are difficult to root from cuttings. By graftage, other varieties are improved in growth, yield of bloom, and earliness. The best stocks are perpetually active, and the plants, being furnished with a good root system, are caused to bloom at a younger age.

Rose Stocks

In considering the stock for the Rose one more desired characteristic should be added to those given on page 109; the stock for greenhouse Roses should be perpetual growing.

Manetti stock. The Manetti is a form of the China Rose. It is obtained from England, France and Scotland, but many do not like the French-grown Manetti because it is not as well graded as the Scotch and English, although the French is cheaper. The English, grown as it is under moister conditions, is also preferred because the bark does not get hard. Manetti grown in this country with our hot Summers

* Good, John M. Springfield Roses. American Rose Annual, 1917, 2d ed., p. 51.

is thought to be too hard for use indoors. The Manetti is not an ideal stock, for although it is perpetual growing and vigorous, and responds to fertilizer readily, it suckers badly Some nurserymen advise budding low on it because suckers rarely start from the roots but generally from the crown. For Roses to be grown in greenhouses it seems the best stock on account of its not needing to rest.

Canina stock. Canina stock is used in England, but it is not good here. Many of our garden Roses imported before the establishment of Quarantine 37 were often budded on *Rosa canina*; but they do not succeed because they have a tendency to stand still in the greenhouse in December to February.

Standard or tree Roses are budded upon Canina. Seedling Caninas have a deep root system, making them less liable to drought injury.

Ezon Kempenaar, before the Newport Horticultural Society, February 8, 1916, described the method of gowing *R. canina* stock from seed as follows:

"The ripe seed pods are collected in September; those from strong shoots are best.

"Two weeks after gathering, the pods are placed in a barrel and stirred about with a stout stick until all broken up; water is added which brings the refuse and infertile seeds to the surface; this is skimmed off, leaving only the fertile seeds which are taken, thoroughly incorporated with sand and placed in boxes, which are then buried in the open ground about 10 inches below the surface, where they remain until Spring. They are then sown in beds just as soon as the ground is workable About May 1 the seedlings will begin to make their appearance, and as soon as large enough they are transplanted in rows from 4 inches to 5 inches apart; the following Spring they are planted out in nursery rows 18 inches apart with 6 inches between the plants; at transplanting the tops are cut back, leaving only three or four eyes."

Carolina stock. The Carolina Rose is a native and especially adapted for low, damp ground; under ordinary conditions it suffers from drought, making it useless for outdoor growing because of our hot and dry Summers. It is not very useful under glass because it has a period of rest. It suckers badly when budded.

Multiflora stock. *R. multiflora* makes an excellent stock, for it is hardy, vigorous, and does not sprout from the roots. It is, however, difficult to obtain and the roots are subject to attacks of the nematode or eel worm. It is propagated by seeds for best results because the roots go more deeply and the stock is made more drought resistant.

Setigera stock. Writing of *R. setigera*, Joseph Meehan says:

"Some of the Southern nurserymen already use it, and find it better than the Manetti in their soil, and it does not sucker. It is fairly well known here, and those familiar with it know what a strong, vigorous grower it is. There is no question of its hardiness at all, since it is a northern Rose; it propagates readily from cuttings and seeds; and if one had a stock of it unsold, for grafting or budding purposes, it would still be salable for planting for its beauty. Those not familiar with it will have an idea of its character when told it is the parent of the old climbing Rose, Prairie Queen."

Rugosa stock. *R. rugosa* is commonly used for standard or tree Roses. It is a rather good stock for outdoor Roses of all sorts but being so thorny, it is difficult to work.

Grafted *vs.* Own Root Roses*

In discussing this question we find great differences of opinion.

Grafted Roses. Grafted Roses have the following points in their favor:

1. They make larger plants in less time because the roots are already a year old.

2. Because of the adaptability of certain stocks many Roses, if grafted, may succeed on soil that would be uncongenial to them if on their own roots. Thus, grafted Roses will grow in sandy soils while mostof our commoner named varieties on their own roots prefer a heavy soil.

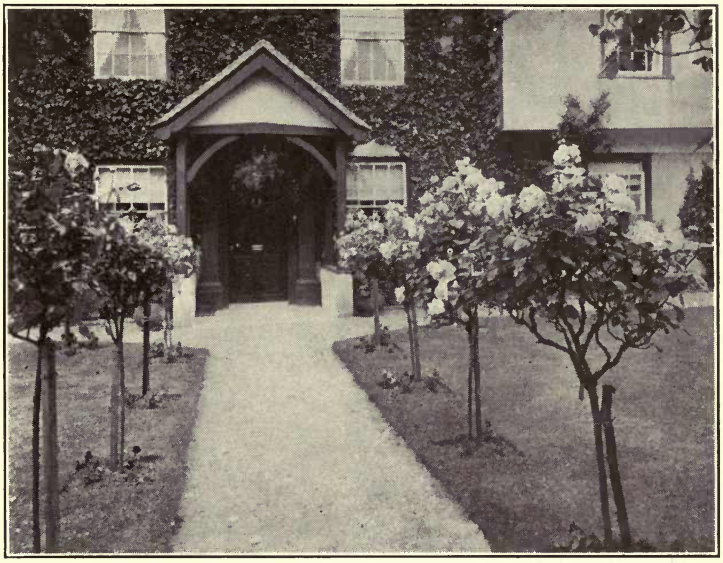


Fig. 90. Standard Roses. The various Hybrid Teas, Teas and Hybrid Perpetuals are successfully budded or grafted upon upright stocks of *R. canina*, *R. rugosa* and other shrubby sorts. Such plants are called Standard or Tree Roses.

3. Grafted Roses have larger root systems and can, therefore, take up more water and plant food.

4. Where stock is limited as with new varieties, each eye will make a plant.

5. Some weak growing sorts are increased in vigor by being grafted.

6. Because of the evergrowing character of certain stocks they may cause a continuous blooming in some varieties that might naturally rest.

* Some of the arguments here presented have been derived from an article in *The Florists' Exchange* of April 27, 1918, by E. G. Hill.

Own-root Roses. By own-root Roses is meant plants which have been rooted from cuttings, that is, they are growing on their own roots. Own root Roses have these points in their favor:

1. Although they do not make as large plants in as short a time, they send up strong "breaks" from the base of the plant after the first of the year. These breaks are often far superior to any "break" which a grafted plant can make.

2. Own-root plants are not so subject to black spot in early Fall. The growth has not been so rapid; it is, therefore, not so soft.

Many yellow sorts, for example, Sunburst and Mme. Collette Martinette, do not make congenial unions with Manetti; they are best on their own roots. Golden Ophelia and Mrs. Aaron Ward are good grafted.

Grafting to Increase Yield

Relative to an increased yield, due to grafting, Alexander Montgomery, Jr.,* writes: "It seems to be the general opinion among those who have never grown grafted stock, that their superiority over own-root plants is chiefly during the early Autumn months. In order to dispel any such notion, I shall give the figures of the cut by months from a house of own-root Roses, and also from the same house planted with grafts. While these figures do not take into consideration the quality of the flowers, still, assuming that the grades are at least equal (and I believe it is generally admitted that they are), they present evidence which ought to satisfy the most skeptical.

Month	Own Root	Grafted
August	6,899	8,653
September	11,317	20,950
October	11,614	9,325
November	10,373	16,558
December	5,829	8,503
January	7,277	10,653
February	4,958	6,775
March	7,634	9,997
April	10,009	13,602
May	13,834	20,813
June	12,991	16,624
Total	102,735	142,453

"This is an interesting record for several reasons: It shows that the same bench space produced forty per cent more flowers on grafted than on own-root plants, a real money difference. The increase is well distributed through the season, the month of Decmber showing an increase of fifty per cent, as compared with the own-root stock."

Grafting Case

Small growers who have refrained from going to the trouble of grafting, could easily build a small frame, which would be handy for many other uses. Most Rose grafting cases are built like a small even-span greenhouse over a greenhouse bench.

E. G. Hill builds his grafting cases so that the top is flat and merely covered by panes of overlapping glass. The case should be 12 to 15

* Montgomery, Alexander, Jr., History and Culture of Grafted Roses for Forcing.

inches high and divided into sections, each large enough for one day's grafting.

A simple case may be made by building up the sides of a bench and covering it with a hotbed sash hinged to the side of the bench. Such cases should be tight and perfectly under control so that a uniform temperature of 80 degrees may be maintained. A layer of coal ashes which is kept moist will supply the humidity for the early growth of the grafts. (See fig. 18.)

Preparation for Grafting

Manetti stock is usually obtained in December and potted into 2½-inch pots. Use a good Rose soil and place the pots in a house with a temperature of 50 degrees. Some growers place the pots under the Carnation benches. They are syringed twice a day to soften the wood

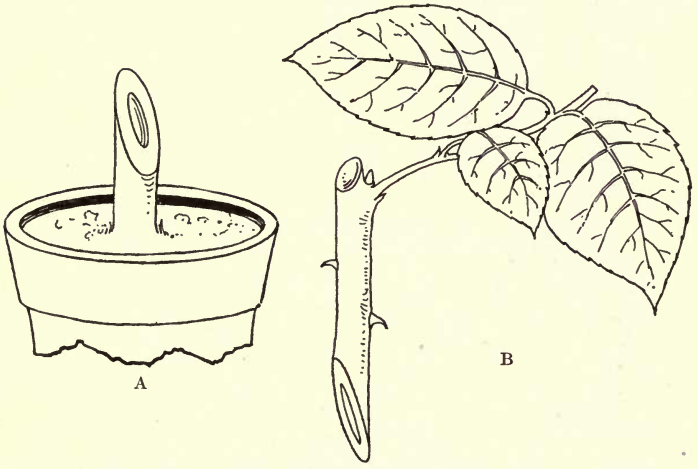


Fig. 91. A—Rose stock cut ready for grafting. From Holmes Com. Rose Culture, p. 36
B—Rose cion for grafting. From Holmes Com. Rose Culture, p. 33
(See page 167)

and cause them to start to grow more uniformly. They should be examined at regular intervals to ascertain when the white roots have started well. Then they are grafted. Cions should be selected which are of the same sort as the wood used for cuttings.

Grafting Operations

The small grower handling only a few hundred Roses had best buy his grafted stock for the process of grafting is rather painstaking.

The splice graft (see figs, 59 and 91) is used, in which the stocks are cut off as near the soil as possible with a long, slanting cut and the cions are prepared with a similar oblique cut A cion is then placed on the stub of a stock with the cambium layers in contact. If the stock and cion are of equal size, the cambium layers will fit on both sides but


CUTTING TAKEN WITH ONE EYE
SUMMER CUTTING OF HYBRID PERPETUAL ROSE
Fig 11
CUTTING THE BUDS
REMOVING THE STUB
Fig 10
CAREFULLY LIFT THE BARK AT THE CROSS-CUT
Fig 5
THE BUD ONE YEAR AFTER BUDDING
THE BEST BUDS ARE THOSE ON SHOOTS WHICH HAVE RECENTLY FLOWERED
HARDWOOD CUTTINGS

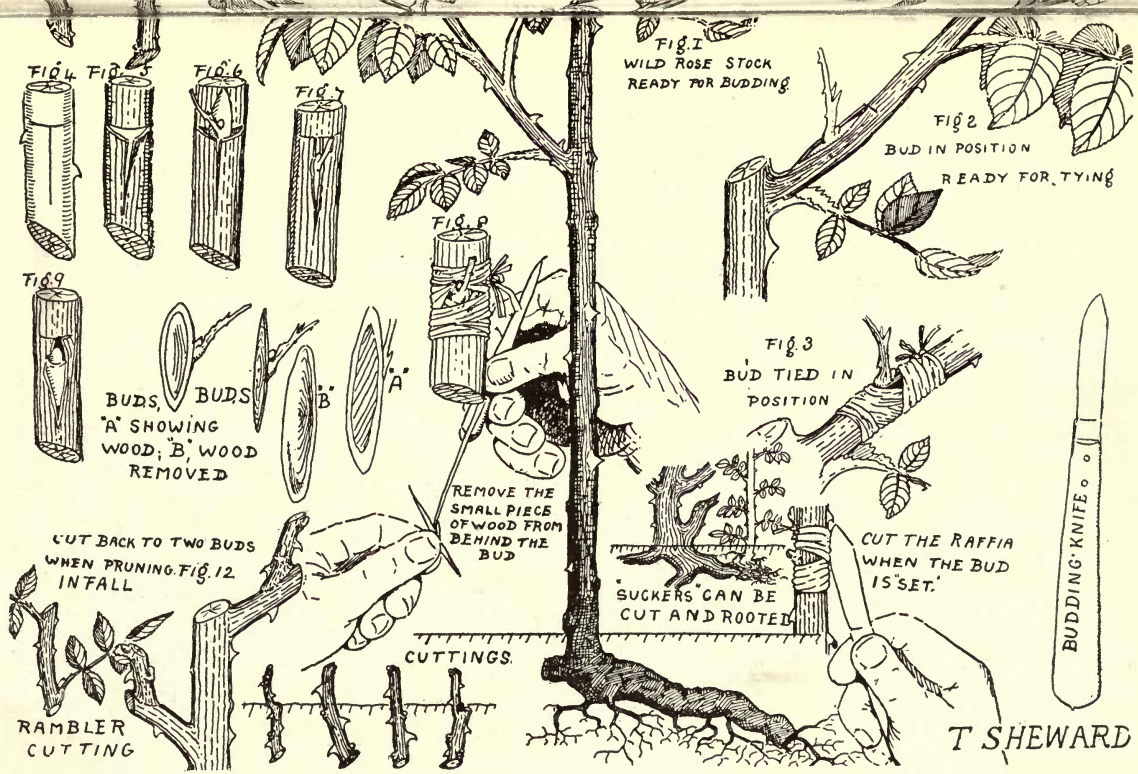


Plate 92 Rose Budding. From the *Canadian Florist*

if the stock is distinctly larger, the cion should be placed so that the cambiums are in contact on one side. The graft is held and tied with raffia which should be previously cut in ten- to twelve-inch lengths.

As soon as they are grafted the plants are watered and placed in the grafting case with a temperature of 80 degrees. Close the sashes tightly and leave for five days Then reduce the temperature to 75 degrees. Keep the case closed except when tending the plants Some plants will unite in 10 days. After 15 days a little air may be admitted, a pot label being inserted under the edge of the sash. When ventilating the house do not open the case.

Do not take the plants from the case until they can stand having the case open all day without wilting; this is usually 3 weeks When they have been removed from the case keep the house closed for several days. Then handle the plants like rooted cuttings.

Budding Roses

Manetti stocks growing in the field are shield budded either in July, when an active eye is used, or in August, with a dormant eye. The early buds will start growth immediately. It will be Spring before the August bud grows.

Most Hybrid Teas, Hybrid Perpetuals, and Tea Roses for outdoor use are budded rather than grafted.

T. Sheward, in the *Candian Florist*, gives a good description of the budding of Roses, as follows:

"Bush Roses are budded low down, half standards 2 feet high, standards 4 feet, and if tall weeping standards are needed, 6 feet to 10 feet is about right.

"In budding ordinary standards the stock is grown 4 feet high and then topped. All the side buds are rubbed out with the exception of two or three at the top according to the strength of the stock. See Plate 92, pps. 168-169. Fig. 1 shows young wood about the size of a pencil, which is the right size for budding.

"In taking the buds use a shoot that has borne flowers, selecting plump buds that show no signs of growing. Trim the leaves off, leaving about one inch of leaf stalk. This is left as a handle. Slice off the bud, beginning a half inch above and finishing a half inch below it. (Fig. 11) Next remove the small piece from behind the bud with the budding knife as shown in "A" and "B" in the illustration.

"To begin work on the stock cut away the thorns where the bud is to be inserted,* about two inches from the base of the shoot (fig. 2). Next make a cross cut through the bark about a half inch long, and another one inch long from this (see fig. 4). Gently raise the bark at the cross cut with the budding knife (fig. 5), and insert the bud (fig. 6 and fig. 2), pushing it down with the leaf stalk (fig. 7), afterward tying it firmly with raffia (figs. 3 and 8).

"The stock shown at fig. 1 should have two buds inserted. If there are three or more suitable shoots these should be budded, too. In about three of four weeks examine the buds and if they have "struck" or taken they will look plump and green (fig. 9)

* Author's note. This is often done a day or two before the Roses are budded so that the wood may heal sufficiently and yet not have time to really get hard as it does when the thorns are removed too far ahead.

"If so, loosen the raffia, and in a few weeks cut with the budding knife, passing it over the raffia on the opposite to the bud, leaving it to fall away. If the raffia is tied too tight and allowed to stay too long it will kill the bud. The bud should remain dormant until Spring

"When pruning in November, cut the shoot away three inches above the bud When the bud starts growing in the Spring cut back close, as illustrated in fig. 10. The following season, when pruning, cut back to two buds. (Fig. 12).

Root cuttings. The fleshy rooted sorts, as *R. gallica*, especially the Moss Roses, *R. damascena*, *R. nitida*, *R. rugosa*, *R. blanda*, *R. lucida*, *R. cinnamomea* and *R. alpina*, may be propagated by root cuttings. Cut up the roots in Autumn and store in sand. Plant out in Spring.

Layers. Dr. Mulford,* writes that *R. Hugonis* is difficult to grow from cuttings and is therefore grown by layers. Let them get thoroughly rooted before cutting them from parent plant. Mound layers are best.

For many of the trailing roses, like *R. Wichuraiana*, continuous layers are useful For that matter, all climbing sorts are readily propagated by this method. The rooting is greatly hastened by cutting into the portion of the stem that is buried.

Trenching method. A modification of layering is described by C. D. Beadle,† Superintendent of the Biltmore Estate. Many of the Briar Roses (like Persian Yellow, Austrian Copper, Penzance Sweet Briars), Damask Roses (including the two-color and striped Roses), and many other types are readily propagated by the trenching process. The plants of the varieties to be propagated are planted out in nursery rows in an almost flat position leaning one against another. The plants are then almost covered with soil on which more may be gradually filled in as the shoots advance in growth. At the close of the first growing season, the trenched plants are dug and the vertical shoots are cut from the horizontal branches at their base. Many of the shoots will have rooted, but this is not necessary. The shoots will, however, be covered with "root-bark," a tissue differing from that of the shoots above the soil. The cuttings, rooted or unrooted, as the case may be, are planted in nursery rows, or in cutting beds, and grown on for several seasons.

Seedling inarch. (For discussion of a method of getting seedlings to bloom quickly see page 129, also see figs. 75-77).

Rapid Propagation of New Varieties

The following notes are from Mr. G. W. Oliver:

"When, as a result of crossing two varieties, a good seedling is secured and tested, the next problem that presents itself is to get up a large stock in as short a period as possible so that it can be put on the market. There are various ways to accomplish this result, but there is only one way to get the maximum number of plants so that cuttings can be rooted for distribution. What is needed is a very quick vegetating stock. The Manetti is too slow for this purpose and it cannot very well be used in Winter. There is a variety intro-

* Mulford, F. L. Roses for the Home. Farmers' Bulletin, 750, p. 27.
† Beadle, C. D. The Trenching Method of Rose Propagation. American Rose Annual, 1917, 2d ed., p. 51.

duced by the Office of Seed and Plant Introduction (No. 22,449, United States Department of Agriculture), which is better for this work than the Manetti and others. This plant is a rampant grower. The bud graft takes quickly on the bases of young stock plants, and when the roots are in good growing condition fine unions result. In a few weeks we get growths a foot or more in length. The growing point is then nipped out and the wood firms up quickly, so that bud wood can be secured for further propagation. To depend upon cuttings alone for increasing a new variety is too slow. Bud grafting gives much quicker results. The bud graft* is simply a piece of matured wood with a single bud. Take a bud stick; remove the leaves and the prickles, if present, from about one-half inch from the stem. To remove the bud grafts place the edge of the knife blade about three-sixteenths of an inch below the opposite side of the leaf joint, cut diagonally down and through the stem about three-quarters of an inch, then turn the bud stick and remove a small slice diagonally from the base of the bud graft which, after cutting from the bud stick, is now ready for inserting into the stock. To prepare the incision in the stock for the reception of the bud graft, simply make a diagonal cut long enough to receive the bud graft, placing the long side of the cut surface of the bud graft so that it will unite perfectly with the inner cut surface of the stock. In a warm house the union will be perfect in two or three weeks. The top of the stock can then be removed gradually. As soon as the ripened shoots are ready they, in their turn, are used in propagating."

VIOLETS

Propagation

Cuttings of the Violet taken in February give good, clean stock for the next year. Use short jointed runners, remove most of the leaves and roots. Some take cuttings as late as April but late propagation gives weak plants. They are placed in the sand bench and treated as soft wood cuttings. Give them plenty but not too much water and be sure to keep them cool (45 degrees) at night if possible Violets are, however, most easily propagated by division, but there is more danger of spreading disease. By the latter method the plants are divided about April 1 so that each cutting will have a few roots and a piece of soft stem and a growing shoot. The cuttings are placed in flats filled with soil. They are left for several days in a shady place, usually under a greenhouse bench, after which they are placed in frames until the season warms up, when they are set in the field about 10 inches apart in the row for singles, and 8 inches apart for the doubles. The rows for convenient cultivation should be 15 to 18 inches apart. Constant Summer cultivation results in good plants.

Improving the Violet Crop

The different varieties of Violets seem adapted to certain localities only, and it is highly advisable for each grower to select the variety,

* This is a modification of the side graft; it differs in that one bud only is used and the cion is made wedge-shaped by being cut on both sides. (See p. 115 and fig. 58.)

and the strain of that variety that meet his conditions best. Dr. Galloway* suggests a method of doing this. The grower should go over his crop, attempting to find those plants which give the most flowers, typically colored, long stemmed, and disease resistant. Suppose one hundred plants are selected; he should place a stake at the side of each and tie a large shipping tag to the stake upon which the daily picking may be written. Some plants may be found to give 50 flowers each; another may produce 150 flowers; some will bloom most in December and January and others in March. Select the strain which produces the most flowers when they are worth the most. At the end of the first year eliminate all plants not producing ninety flowers. Each plant will give ten good cuttings, so that if fifty plants are selected the first year, five hundred good plants are assured for the second. Keep the selected plants labeled. The details of this method can be improved upon according to the ingenuity of the grower.

* Galloway, B. T. Commercial Violet Culture.

CHAPTER VII

HERBACEOUS PERENNIALS

In this list of herbaceous perennials are included the commoner sorts of plants, not woody, which live more than one year. They are all genera of plants which are hardy in the Northern States. The writer acknowledges the help of Professor David Lumsden in preparing this list.

†—Grown from seed usually not blooming until the second year.

*—Bloom first year from seed, but the perennials are not at their best until the second year.

A—Some species are annuals which, obviously bloom the first year from seed.

D—May be propagated by division.

E—Everlasting or Immortelle flowers.

G—Grasses.

K—May be propagated by suckers or stolons.

R—May be propagated by root cuttings.

S—May be propagated by stem cuttings.

O—Self sow.

V—Vine.

Abronia D,†
Acanthus D,†
Achillea D,*
Aconitum D, Fall or Spring
Acorus †,S,D
Actæa †,S,D
Adlumia *,V,S
Adonis *,D, divide in Autumn
Ægopodium D
Agrostemma O (See Lychnis)
Ajuga †,S,D
Althæa D,O (certain strains*)
Alyssum *,A,S,D
Amsonia †,S,D
Anchusa †A,D,R,O
Anemone †,R,D
Anthemis *,D,O
Anthericum K,D
Aquilegia †,D,O
Arabis *,D,O,R
Arenaria †,S,D
Armeria †,D
Arnica D
Artemisia †,A,D
Arundo G,D
Asclepias †,D,R
Asperula *,D
Asphodelus †,D
Aster S,D
Astilbe D
Aubrietia †,S,D. Sow early so that seedlings are established before Winter.
Auricula *,D
Baptisia †,D. Sow seed as soon as ripe.
Bellis *,D. Sow seed in Fall.
Bocconia †,R,K,D. Sow seed in April.
Boltonia †,D
Borago †,A,D
Callirhoe †,S,D
Calluna S,D. Cuttings December to April
Campanula †S,A,D
Caryopteris †,S,D
Cassia †,S
Catananche †,E,D. Sow seed in Fall indoors.
Centaurea †,A,S,D,O
Centranthus †,D
Cerastium*,A,D,O
Ceratostigma †,S,R
Chelone*
Chrysanthemum †,A,S,D
Cimicifuga †,D
Clematis †,S,D. Sow seed when ripe
Clintonia D
Coreopsis *,A,D,O
Coronilla †,R,D
Cortaderia G,D
Corydalis †,D
Delphinium * and †,A,S,D,O
Dianthus † and *,K,A,S,D,O

Dicentra R,D. Divide early Spring
Dictamnus †,D. Sow seed as soon as ripe
Digitalis †,O
Dodecatheon †,R,D
Doronicum *,D
Draba †,D
Dracocephalum †,D

Echinacea †,D
Echinops †,D
Epimedium D
Erigeron †,D
Eryngium †,D
Eupatorium †,S,D
Euphorbia †,D

Farfugium D
Funkia †,D. Some species sow as soon as ripe

Gaillardia *,A,R,S,D
Galega †,D
Galium *,A,D
Gaura †,D
Gentiana †,D
Geranium †,D
Geum †,D
Gillenia †,D
Gynerium †,G,D
Gypsophila †,A,S,R,D Double *G. paniculata* is grafted on single.

Hæmadorum D
Hedysarum †,D
Helenium †,S,D
Helianthemum †,D
Helianthus *,A,K,S,D
Heliopsis †,S,D
Helleborus †,D. Sow as soon as ripe
Hemerocallis †,D
Hepatica †,D
Heracleum *,D
Hesperis †,S,D,O
Heuchera †,S,D. Divide October
Hibiscus *,D
Hypericum * or †,D
Hyssopus †,S,D
Iberis †,A,S,D. Seedlings poor first year
Inula †,D
Iris D (California species must be from seed) †
Kniphofia †,D, some *
Leontopodium *,D. Sow in February
Liatris †,D
Linaria *,A,D
Linnæa S,D. Under glass.
Linum *,A,D
Lobelia †,A,D. Sow in late Summer
Lotus †,S
Lupinus †,A,D. Seedlings do not transplant well; sow in pots or where they are to stand.
Lychnis *,A,S,D
Lysimachia S,D
Lythrum †,S,D

Mandragora †,D
Menispermum S,D.
Mentha †,K,S,D
Menyanthes D
Mertensia †,D
Mesembryanthemum †,S
Monarda †,R,S,D. Divide Spring
Myosotis *,A,S,D

Œnothera †,A,K,S,D
Orobus †

Papaver (Iceland*), K, A,D. Do not transplant seedling *P. orientalis* until August, then pot for Spring trade.
Pardanthus †,D
Pentstemon †,D
Peony R,D,O
Phalaris †,G,A,D
Phlomis †,S,D
Phlox * and †, A,R,S, D,O
Physostegia †,S,D
Platycodon †,D
Plumbago (see Ceratostigma)
Podophyllum †,R,D
Polemonium †,D
Polygonatum D
Polygonum †,R,S,D
Potentilla †,D
Primula †,D
Pulmonaria *,D
Pyrethrum *,D

Ranunculus †,S,D
Rheum †,D
Romneya †,R,K
Rudbeckia †,A,S,D. Divide in Spring

Salvia *,A,S,D. Sow seed and make cuttings in Fall.
Sanguinaria †,D
Santolina †,S,D
Saponaria †,S,R,D
Saxifraga †,A,K,D
Scabiosa †,A,D
Scutellaria †,D
Sedum *,S,D
Senecio *,S,D
Sidalcea †,D
Sielene †,A,S,D. Sow seed in September
Silphium †,D
Sisyrinchium D
Solidago †,S,D
Spigelia †
Stachys †,D. Divide in Spring
Statice †,E,A
Stokesia †,R,D

Tanacetum S,D
Thalictrum †,D
Thermopsis †,R,D
Thymus *,D
Tiarella D,K
Tradescantia †,S,D
Trollius D
Tunica *,D

Valeriana †,D
Verbascum †,S,D
Veronica †,S,D. *V. longifolia subsessilis* by cuttings Summer.
Vincetoxicum †,D
Violas *,D

Yucca †,S,R,D

ANNUALS

Annuals are plants which live but one year, the seed is sown, the plants bloom and seed all in one year. There are three classes of annuals according to their culture: Hardy, tender and half hardy.

Hardy annuals are usually sown where they are to grow, as early as the soil can be worked. They often self-sow, such annuals may, therefore, be sown in the Fall if one prefers.

Tender annuals will tolerate neither the cold soil of early Spring, the freezes of Winter, nor the slight frosts of the Fall. The seeds of such sorts must be sown indoors from January to May or in the open soil when the ground is warm.

Half hardy annuals, though often hardy enough, have a long growing season and do not reach their proper development unless sown in the greenhouse, hotbed or coldframe in March.

Some annuals, especially the Pea-, Poppy- and Melon-like sorts, those with taproots principally, are difficult to transplant. Either sow the seeds in thumb pots or in their permanent quarters. In the case of the other annuals transplanting is beneficial, in that the roots slightly broken are induced to branch making the plants stocky and more easily transplanted in the future.

E—Everlasting.
S—Stem cutting.
O—Self sow.
G—Ornamental grass.
V—Vines.
H—Hardy.
HH—Half hardy.
T—Tender.

Acroclinium E, HH. Sow in March.

Ageratum (Floss Flower) T,S,O. Sow in February in flats.

Agrostis (Cloud Grass) G,H. Sow in March or April.

Alonsoa (Mask Flower) S,HH. Sow in March indoors.

Alyssum, Sweet O,H. Sow in April and every three weeks for succession of bloom.

Amarantus T. Sow in March indoors; May outside.

Ammobium E, HH. Sow in March indoors.

Anchusa HH. Sow in March indoors.

Antirrhinum (Snapdragon) H,S,O. January for garden, April for Fall bloom; July for Winter; September for May 30. Sow 60-100 days before benching. Germinate one week. Transplant in four weeks.

Arctotis (African Daisy) HH. Sow April.

Argemone (Horned Poppy) O,H. Sow May, do not transplant.

Aster, China (See Callistephus).

Balloon Vine HH,V. Sow outside in May.

Balsam O,H. Sow April. Transplanting dwarf plants improving their appearance.

Bartonia (See Mentzelia).

Brachycome (Swan River Daisy). Sow March or April indoors; for Spring bloom in greenhouse, sow September.

Briza (Quaking Grass) G,H. Sow in April outside.

Bromus H,G. Sow in April outside.

Browallia H,O. March for bedding, July for Winter bloom.

Cacalia HH. Sow in May.

Calendula (Pot Marigold) o,h. Sow February for Memorial Day; sow April for Summer cutting.
Callistephus (China Aster) hh. Sow in March or April indoors; May for late bloom, in frames outside.
Canary Bird Creeper v,t. Sow in May.
Celosia (Cockscomb) t. Sow in April indoors or in May outside.
Centaurea Cyanus h,o. Sow in April; most other annuals, hh. Sow in May or April indoors. Some difficult to transplant.
Cerinthe hh or t. Sow in May.
Cheiranthus (Wall Flower) h. Sow February; transplant to open in May; dig for Winter bloom.
Clarkia h. Sow in May.
Cleome (Giant Spider Plant) o,h. Sow in May.
Cobæa v,hh. Sow March, sandy soil, 60 degrees. Press seed into soil edgewise.
Coix (Job's Tears) g,h. Sow seed either indoors in April or outside in May.
Collinsia hh. Sow in May.
Convolvulus (Morning Glory) o,v,h. Sow in late April.
Coreopsis (Calliopsis) o,h. Sow in April.
Cosmos o,h. Sow in April.
Cypress Vine v, hh. Sow in May. Soak seeds in warm water.
Datura (Angel's Trumpet) hh. Sow in May.
Delphinium (Larkspur) o,h. Sow early May.
Dianthus (Pinks) h. Sow in April indoors, May outside.
Diascia t. Sow September for March bloom in greenhouse; sow April indoors.
Dimorphotheca hh. Sow February for Spring sales.
Dolichos (Hyacinth Bean) v,t. Sow in May when soil is warm.
Echinocystis (Wild Cucumber) h,v,o. Sow in May.
Emilia hh. Sow April indoors, May outside.
Erysimum h. Sow February for Spring bedding.
Eschscholtzia (California Poppy) o,h. Sow May. Do not transplant.
Euphorbia (Painted Leaf and Snow on the Mountains) o,h. Sow in late April.
Gaillardia (Blanket Flower) h. Sow in May where they are to grow.
Gilia hh. Sow in May.
Godetia o,h. Sow in May.
Gomphrena (Globe Amaranth) e,h. Sow indoors March, outside May.
Gourd v,t. Sow late May.
Gypsophila (Baby's Breath) h. Sow in succession May every two weeks.
Helianthus (Sunflower) h. Sow in April.
Helichrysum (Strawflower) e,hh. Sow indoors March.
Helipterum e,hh. Sow indoors March.
Hordeum g,hh. Sow February or March.
Hunnemannia hh. Sow in March in small pots. Do not transplant.
Iberis (Candytuft) h. Sow January for Memorial Day; May outside.
Ipomœa h,s. Soak seed 24 hours in warm water.
Kochia (Summer Cypress) o,h. Sow in April or May.
Lavatera hh. Sow in May where they are to bloom.
Layia hh. Sow in April.

Linaria. *L. reticulata aurea purpurea* T. Sow in January, bloom in March.
Linum (Flax) H. Sow in May.
Lobelia S,HH. Sow in February for Spring bedding.
Lupinus HH. Sow early May, do not transplant.
Madia HH. Sow in May.
Malope HH. Sow in May.
Matthiola (Stocks) S,H. Sow in August for Winter; sow in February for Memorial Day; April for garden.
Maurandia V,HH. Sow indoors in March or April.
Mentzelia T. Sow in May. Do not transplant.
Mimulus (Monkey Flower) HH. Sow in March indoors.
Mirabilis (Four o'Clock) O,H. Sow in April indoors.
Nasturtium T. Sow May outside.
Nemesia T. Sow September for Spring bloom. Sow indoors February for Summer.
Nemophila T. Sow in May where they are to flower.
Nicotiana (Ornamental Tobacco) T. Sow in March indoors.
Nierembergia (Cup Flower) H. Sow in September, Winter in coldframe.
Nigella (Love-in-a-Mist) O,H. Sow April or May.
Pansy O,H. Sow August for Spring bloom; sow Spring for Summer bloom.
Papaver (Poppy) O,H. Sow April. Do not transplant.
Pennisetum (Fountain Grass) G,HH. Sow February 20th.
Petunia S,O,H. Sow indoors in April, transplant May.
Phacelia T. Sow in January, blooms in March, or sow in May for outside.
Phaceolus (Scarlet Runner Bean) V,T. Sow in May. Do not transplant.
Phlox HH. Sow in early April, transplant to open.
Poinsettia H,O. Sow in May.
Portulaca (Sun Rose) O,H. Sow in May.
Reseda (Mignonette) T. Sow March to April in pots; April outdoors; August for Winter.
Ricinus (Castor Bean) T. Sow in separate pots, late March.
Rhodanthe (Swan River Everlasting) E,HH. Sow in March.
Salpiglossis (Painted Tongue) HH. Sow in April.
Salvia (Scarlet Sage) T,S. Sow February in flats; 50 degrees, to save seed pick stems when bracts turn brown, seeds may not be black. Place in dry, airy room.
Sanvitalia H. Sow in April or May.
Scabiosa (Pincushion Flower) H. Sow in May.
Schizanthus (Butterfly Flower) T. September for greenhouse use; sow March indors; May outside for garden use.
Statice E,HH. Sow in March.
Sweet Peas H. Sow for outdoors in pots in March or open ground March. See p. 40 for indoor dates.
Tagetes (Marigold) O,H. Sow in April.
Thunbergia (Black-eyed Susan Vine) V,HH. Sow March indoors.
Torenia (Wishbone Flower) T. Sow indoors March; open ground May.
Verbena S,HH. Sow January for early sale.
Whitlavia HH. Sow in May.
Xeranthemum E,HH. Sow in March.
Zinnia O,H. Sow in April.

BULBOUS PLANTS AND THEIR PROPAGATION

B—Bulblets
C—Cormels
Co—Corm
D—Natural division
O—Offsets
R—Rhizomes which may be divided
S—Seed
Sx—Western species, by seed only
T—Cuttings
Tu—Tubers and tuberous roots
*—Sometimes grafted to preserve rare or weak varieties
†Spring flowering, out of doors
‡—Winter flowering
X—Summer flowering, hardy
Z—Summer flowering, not hardy

Achimenes R,T,Z
Agapanthus D,Z
Allium S,O,B,‡,†
Alstrœmeria S,D,Z
Amaryllis S,D,O,‡
Amorphophallus O,S,Z
Anemone S,D,‡,†
Anomatheca (see Lapeyrousia)
Antholyza D,Z
Apios Tu,Z
Arisæma Co, or Tu,S,†
Arum O,S,‡
Babiana C,S,‡
Begonia, tuberous S, Tu,Z
Bessera O,Z
Bloomeria Co,S,†
Boussingaultia B,Z
Brodiæa S,O,‡
Bulbocodium D,†
Caladium Tu,Z
Calochortus Co,D,‡
Camassia S,D,X
Canna R,Z
Chionodoxa O,S,†
Clintonia D,†
Clivia D,Z
Colchicum D,S,X
Convallaria R,†
Cooperia D,Z
Crinum D,Z
Crocosmia O,S,Z
Crocus D,Co,S,†
Crown Imperial D,†
Dahlia*, S,D,T,Tu (see pp. 33, 94, 95) ,Z
Dracunculus Tu,O,‡
Eranthis D, †
Eremurus D,S,X
Erythronium O,Sx,†
Eucharis O,
Freesia O,S (2-3 yrs.)‡
Fritillaria O, †
Funkia D,R,X
Galanthus D, †
Galtonia S,D,Z
Geissorhiza Co,D
Gesneria S,‡
Gladiolus (see p. 93,) C,C,S,Z
Gloriosa D of Tu,O,Z
Gloxinia S (see pp. 39, 81, 96)
Helleborus R,D,†
Hippeastrum (See Amaryllis)
Hyacinth (see pp. 87-92) ‡,†
Hymenocallis O,Z
Imantophyllum (see Clivia)
Iris, bulbous D,‡,†
Iris, rhizomatous R,S, †,X
Iris, Californian species Sx,X,
Ismene (see Hymenocallis)
Ixia O,‡
Ixiolirion D,†
Kniphofia S (a strain Burpee has developed),D,X
Lachenalia D,S,‡
Lapeyrousia Co,D,X
Leucojum D,O,†X,
Lilium (see pp. 92,150, 154) B, ‡,†,X
Lily of the Valley R,†
Lycoris D,Z
Milla D,Z
Montbretia (see Tritonia)
Moræa Co,D,Z
Muscari O,S,†
Nægelia O,‡
Narcissus D,‡,† (see pp. 86-92)
Narthecium R,X
Nemastylis D,Z
Nerine O,Z
Ornithogalum O,†
Oxalis D,O,‡,Z
Pancratium O,S,Z
Polygonatum R,D,T
Puschkinia D,†
Ranunculus S,D,†
Richardia (see Zantedeschia)
Scilla O,‡,†
Smilacina R,†
Sparaxis D,‡
Spiræa (Astilbe) D,S,‡
Sprekelia D,‡,Z
Tigridia C,S,Z
Trillium R,S,†
Triteleia S,O,†
Tritoma (see Kniphofia)
Tritonia D,‡,X
Tuberose O,Z
Tulip (see pp. 89, 92) ‡,†
Vallota D,O
Watsonia C,D,‡,Z
Zantedeschia D,O,S,‡,Z
Zephyranthes D,S,‡,Z

CHAPTER VIII

TREE AND SHRUB LIST

Many of these notes are derived from those made by Mr. Joseph Meehan in the Florists' Exchange.

*Indicates the best method of propagation.

ABELIA.
CUTTINGS. Hard, half-ripened wood in October under glass.
LAYERS. In greenhouse best.

ABIES. Firs.
SEEDS. Keep dry during Winter, sow in Spring. Many of the seeds are infertile.
GRAFTING. Grafted on seedlings, use veneer graft. Grafting in greenhouse in late Summer or Winter. Use only upright growing shoots for cions, others do not make shapely trees.
INARCHING. Successful.

ABUTILON. Flowering Maple.
SEEDS. Sow in March. Will bloom in Autumn.
*CUTTINGS. Hard or soft wood.
GRAFTING. Any strong growing species may be used upon which to graft the trailing sort, *A. Megapotamicum*, in order to make a standard plant.

ACANTHOPANAX. Angelica Tree.
CUTTINGS. Hard or half ripe wood.

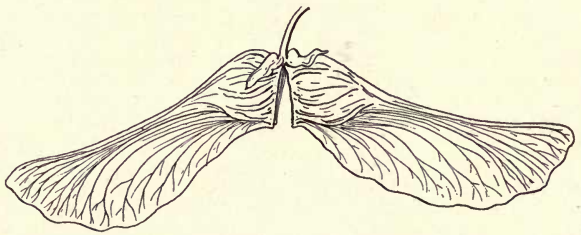


Fig. 93. A Maple key

ACER. Maple. Box Elder.
SEEDS. Many of the species grow well from seed sown as soon as ripe or stratified and sown in the Spring. *A. palmatum*, var. *atropurpureum*, *A. p. dissectum*, and *A. p. sanguineum* come true from seed and are stronger than grafted plants.
CUTTINGS. Some species root from hardwood cuttings, *A. negundo* especially.

ACER—Continued

LAYERS. *A. rufinerve*, *A. rubrum*, *A. cappadocicum* (*colchicum*) var. *rubrum*, *A. platanoides* var. *Schwedleri*, *A. platanoides* var. *globosa* and *A. palmatum*, are best propagated by cutting down a tree and encouraging long shoots to grow which are layered. Sometimes it is not necessary to cut down the trees to induce the growths. It takes some Maples two years to root.

GRAFTING AND BUDDING. Varieties are grafted or budded on types, for example, *A. saccharinum* var. *Wieri* is budded on its species *A. saccharinum;* Schwedler's Maple, and *A. globosa* are grafted or budded on *A. platanoides; A. palmatum* (*polymorphum;*) *atropurpureum* or *A. p. dissectum* is grafted on *A. polymorphum; A. negundo* var. *variegata* is grafted on *A. negundo.* Two-year-old seedlings are best. Graft in April. Bud in August. The Japanese Maples are usually grafted in the greenhouse. Marinus Van Kleef describes the following method of outdoor grafting as used in Holland:

"The best time to graft Japanese Maple in the open is in the latter part of July or the first part of August. The stock used to place the cion on is *Acer polymorphum*, a rapid growing variety of the Japanese Maple, which may be grown easily from seed. Two or three year old seedlings are best planted such a distance apart that later on, after grafting, the plants have sufficient room to develop into salable specimens. If the soil is not very fertile it is necessary to transplant them before they are salable, to insure a good fibrous root system.

"The cions must not be cut too long in advance before grafting takes place, as they should lose none of their vitality by withering. The cions may be 8 inches to 10 inches long. The tops are shortened a little. Do not select soft, sappy wood for cions, but sturdy, hard twigs of this Summer's growth. Two downward cuts about 1½ inches long in the form of an inverted V (see p. 128) are made in the stock in the smoothest part of the bark about 6 inches above the soil and just through the bark. These cuts form a flap which is raised but not removed. The cion is cut on two sides about 3 inches from the lower end also just through the bark, the bark in these cases being removed. The cuts on the cion must be about the same length as on the stock. As the cion usually is thinner than the stock, it must be placed obliquely against the stock and in such a way that the bark of cut surfaces of stock and cion cross each other. A cotton thread is sufficiently strong to unite the stock and the cion, but wool is safer as it will 'give' with the expansion due to growth.

"After the two are bound with the thread, a bottle filled with water is tied to the lower part of the stock and the lower end of the cion is placed in the water. Ordinarily medicine bottles are large enough for this purpose, but if bottles with wide necks are available they will be found more convenient when occasionally it is necessary to refill them before stock and cion are united. This water preserves the cion during the action of union, and prevents it from withering. It does not take long with favorable weather conditions for the stock and cion so unite.

"When the union is complete the stock supplies the cion with sap for its further development, so water is no longer necessary and the bottle may be taken away. The lower part of the cion which was in the bottle is cut off just below the union when the bottles are removed. Early in the Spring the stock is cut off just above the place of union.

"To obtain beautiful specimen plants, especially with the taller growing varieties, it is necessary to place sticks alongside of them. To these the young shoots may be tied. A Japanese Maple does not

ACER—Continued

need much trimming; in fact, most of the dwarf growing varieties should not be trimmed at all, since letting them grow as Nature wishes, greatly promotes the Japanese effect."

INARCHING. Many of the Japanese Maples are inarched on seedlings. Best done from June to September.

ACTINIDIA. Japan Gooseberry.

SEEDS. Sown in Spring or late Winter.

CUTTINGS. Best use green shoots in Summer. Roots form readily, but buds are tardy to grow.

LAYERS. During Spring or Summer.

ADENOCARPUS.

CUTTINGS. Unripe wood in greenhouse.

ÆSCULUS. Horse Chestnut. Buckeye.

*SEEDS. Many species grow readily if sown as soon as ripe or stratified over Winter. *Æ. carnea* (*rubicunda*) rarely seeds.

ROOT CUTTINGS. *Æ. parviflora* is so propagated.

BUDDING. *Æ. carnea* (*rubicunda*) and *Æ. hippocastanum* var. *flore pleno* are budded on *Æ. hippocastanum* in July or veneer grafted under glass during August upon year-old seedlings.

DIVISION. Some of the dwarf sorts are best propagated by division of the crowns.

AILANTHUS. Tree of Heaven.

SEEDS. Stratify during Winter; sow shallow in Spring.

SUCKERS when roots are injured.

ROOT CUTTINGS. Propagate from pistillate trees; female trees have bad odor.

AKEBIA.

SEEDS. Sown in Fall or Spring in coldframe.

CUTTINGS. Hard wood, or soft wood in Summer.

LAYERS. Of hard or soft wood.

ALBIZZIA.

SEEDS. Sow seed as soon as ripe. Soak in warm water 24 hours.

CUTTINGS. Under glass.

ALNUS. Alder.

*SEEDS. Sow in Fall or Spring. Cover lightly. Keep moist.

CUTTINGS. Ripe wood.

GRAFTING AND BUDDING. Bud or graft varieties on the type. *A. firma* is best grafted on *A. glutinosa*. The Heart-leaved Alder (*A. cordifolia*) is useful as stock for those sorts to be grown on a dry soil.

AMELANCHIER. June Berry. Shad Bush.

*SEEDS. Sow as soon as ripe, or stratify until Spring.

SUTTINGS. Hard wood.

ROOT CUTTINGS. Bury in sand in cellar during Winter, plant in Spring horizontally.

BUDDING AND GRAFTING. Dwarf sorts grafted on tall stocks. *Cratægus* may be used as stock.

AMORPHA. False Indigo.

*SEEDS. Sow seed as soon as ripe. This is commonest method.

CUTTINGS. Hard wood cuttings. Take in Autumn. Also green wood

AMPELOPSIS. Boston Ivy. Virginia Creeper. Woodbine.
SEEDS. Sow seeds as soon as ripe or keep in moist sand until Spring.
*CUTTINGS. Hard wood or soft wood in Summer or Spring in heat.
LAYERS. Simple layers used.

ANDROMEDA.
*SEEDS. All varieties grown from seed. Very fine. Sow in pots in Spring, place in frames in mixture of sphagnum, fine loam; cover with glass. Germinate in two months but grow slowly.
CUTTINGS. Soft wood in Summer.
LAYERS. Root slowly.

ARALIA. Hercules' Club. Devil's Walking Stick.
*SEEDS. Good, when they can be obtained, of *A. spinosa* and *A. japonica.*
*ROOT CUTTINGS. In Spring. About 2 to 3 inches long; set out in rows or take in Autumn and store in sphagnum moss, or sand.
GRAFTING. Some of the exotic sorts require grafting upon strong growers. Done in greenhouse.

ARBUTUS. Strawberry Tree.
SEEDS. Sown in Autumn or early Spring.
CUTTINGS. Half-ripe in Autumn placed in peaty soil.
GRAFTING AND BUDDING. Budded on seedling stock of the European species *A. Unedo.* Veneer graft used.

ARCTOSTATHYLOS. Bearberry.
CUTTINGS. Half ripe wood.

ARISTOLOCHIA. Dutchman's Pipe.
SEED.
GRAFTING. Using *Aristolochia siphon* for quick results.

ASIMINA. Pawpaw. Custard Apple.
*SEEDS. Self sow. Or stratify and sow in Spring.
LAYERS. In Autumn.
SUCKERS when roots are injured.
GRAFTING. *A. triloba* seedlings are used as stock for the weaker growers and varieties.

AUCUBA. Gold-dust Tree.
SEEDS. Sown soon after maturity. The male and female flowers are on separate plants.
CUTTINGS. Green or half-ripe wood, rather long cuttings often used. 8-10 inches.
LAYERS. Made of berried branches.
GRAFTING. Varieties are often grafted on the type.

AZALEA.
SEEDS. Sow seed when ripe. Use leafmold and loam. Best sown in greenhouse. *Azalea mollis* and its variety. J. C. Von Thol, come true from seed.
CUTTINGS. Half-ripe wood. Indoor grown plants root more easily than outdoor ones. It takes several years for cutting grown plants to bloom. *A. Hinodigiri, A. amœna,* and *A. yodogawa* propagated by cuttings.
GRAFTING. See Rhododendron. Veneer graft used indoors in the Summer. *A. viscosa* and *A. nudiflora* make excellent stocks; especially the first, which is the stronger grower. *A. ponticum* is used for all the hardy sorts except the Japanese.
LAYERS. *A. viscosa* and *A. amœna.* Simple layers. Spring.

BACCHARIS. Groundsel Shrub.

SEEDS.

CUTTINGS. Hard wood.

BENZOIN (Lindera). Spice Bush. Wild Allspice.

*SEEDS. Sow seeds as soon as ripe, using a peaty soil.

CUTTINGS. Green wood, but are difficult to root.

BERBERIS. Barberry.

*SEEDS. Sow seeds as soon as ripe, sowing in a seed bed, covering bed with leaves during Winter. Keep seedlings in partial shade at first. Even the Purple-leaved Barberry comes true to seed.

CUTTINGS. Readily propagated by green cuttings in June. The hard wood cuttings do not root readily.

GRAFTING. Mr. Dunbar suggests grafting the rarer sorts on the Purple Barberry; the suckers are thus easily distinguished.

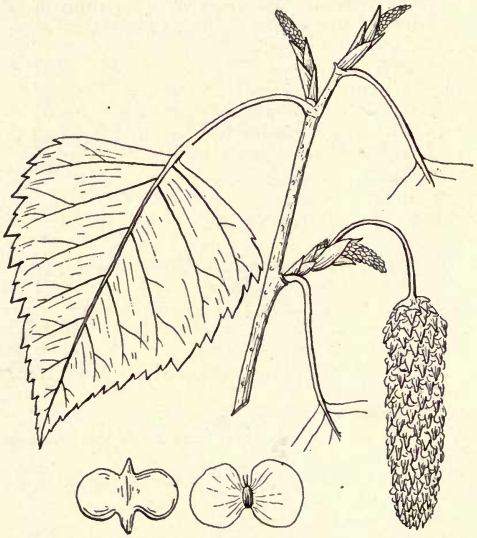


Fig. 94. The seed cone of the Birch

BETULA. Birch. (See fig. 94.)

*SEEDS. Sow seeds as soon as ripe; *B. lenta* matures seed in June If planting is deferred until Autumn poor germination results; 75 per cent of pyramidal Birch comes true.

LAYERS. The lower growing sorts may be layered; the larger sorts may be cut back to mound layer each year.

BUDDING AND GRAFTING. Easily done on seedlings of *B. nigra*, the Red Birch; *B. lenta*, the American Sweet Birch; or *B. papyrifera*, the Paper Birch.

B. Youngi pendula, *B. pyramidalis*, *B. pendula*, are budded chiefly, but may also be grafted

BIGNONIA. Trumpet Flower.

*Cuttings. Half mature cuttings of evergreen sorts best placed under bell jars to root.

*Layers. Simple layers used.

Root Cuttings in Greenhouse. Of larger rooted sorts.

BLACKBERRY.

Root Cuttings. Fall; about thickness of lead pencil. Cut into 2 to 3 inch lengths. Store in sand or sawdust until Spring.

BLUEBERRY. (See Vaccinium.)

BROUSSONETIA. Paper Mulberry.

Seeds. The tree is dioecious.

Cuttings. Hard and half-ripe wood.

BUDDLEIA. Summer Lilac. Butterfly Bush.

Seeds. Sown under glass in February. Seedlings often grow 6 feet in six months.

*Cuttings. Use either soft or hard wood cuttings.

BUXUS. Box Tree. Boxwood.

Seeds. Very slowly grown from seeds.

Cuttings. Made of late growths taken in Winter, root by Spring; or younger wood may be rooted in Summer. Pot and grow in frames for a season. Marinus Van Kleef describes a method as follows:

"The best way is to grow them from hard wood cuttings during the early Summer after the growth is settled. It is advisable to select twigs of good size. The foliage must be stripped off the lower part of the twig for about 2½ inches, while the bottom must be cut with a sharp knife—a clean cut heals quicker than one made with a dull knife. Do not cut off the foliage; stripping the leaves is far better. When stripped, a small piece of bark is torn off the twig where every leaf was. This injury quickly heals over, and on the cambium so exposed roots form quickly. To promote root forming, press the cutting into the soil almost doubled up. Place the first finger of the right hand nearly in the center of that part of the cutting which is stripped of the foliage. The action of bending the cutting while pressing it into the soil causes the bark to crack in several places on the bent part. These injuries heal very quickly; cambium forms on the wounds and from the cambium roots develop. (See fig. 95.)

"Your frame, of course, must be first prepared ready to receive the cuttings. Many people are of the opinion that it is absolutely necessary to remove the soil out of the frame to a certain depth, place a quantity of manure in the bottom, and cover the manure with about 8 inches of soil to promote the bottom heat. This is not so, although it is advisable to prepare the frame that way if the cut-

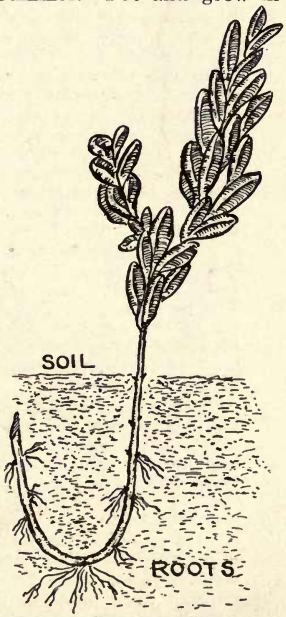


Fig. 95. The large roots from the lowest point in the bend of the cutting come from the new cambium layer formed where the bark cracks. The smaller roots above come from the cambium layer formed where the leaves are stripped off

tings are made in the Fall, because then the bottom heat will force the formation of roots before Winter begins. Bottom heat is necessary when cuttings are made in the Fall, as without the heat not many cuttings would form roots. However, as stated, if the cuttings are made in the early part of Summer, the warm weather will enable the cuttings to have nice roots before the Fall.

"It is best to build the frame in such a way that it is nearly level with the ground, when the cuttings can easily be protected during the Winter with a lot of manure and some mats.

"A light, sandy, rich soil is the best to place Boxwood cuttings in. In making cuttings the taller ones can be selected for the purpose of forming pyramid Boxwood, while the short, stocky ones are best for future bush Boxwood. It is advisable to even up the short cuttings a little on the tops.

"The cuttings are placed about 2 inches apart each way, and for the next six to eight weeks the frames must be covered with sash. As root forming takes place quickest in the dark, the glass must be heavily whitewashed and covered with lath or thin mats to keep the sun out entirely. If the cuttings were not kept in a quite dark place the foliage would commence to grow and no roots would form. The cuttings must be watered copiously so that the soil is kept moist, while in extra warm weather a light spraying a few times a day will be beneficial. On warm days they also must be aired. In about two months the sashes are taken away and the cuttings can be protected by lath only until the cold weather sets in. Then the sashes must be placed on them again.

"As Boxwood cuttings in their young stages are very tender, fully adequate protection must be given them during the Winter. When Spring is at hand this protection can be taken away and, to obtain a nice growth before they are planted out, the following must be done: Feed the plants with plenty of liquid manure at the first signs of Spring, leave the sashes on them, and keep them as warm as possible, watering them abundantly. Care should be taken not to burn them.

"When they have made their first growth they can be planted out. When planting out it should be taken into consideration that Boxwood needs rich soil, considerable moisture and, if possible, plenty of shade. The best place for Boxwood is where it can be watered occasionally during dry weather. If one has a block of Maple trees Boxwood can be planted in the rows, and the shade of the trees will do them good while, at the same time, the same trees will protect them during the Winter.

"However, most Boxwood, and Rhododendrons also, are rarely killed by frost. It is the sudden change of temperature about March (in the latitude of New York) that does most of the harm. One day it may be very cold, while the next day the sun will shine warmly on the foliage, thawing it out too suddenly. It is this hot sun on the foliage, right after severe, cold nights that does most harm to both Boxwood and Rhododendrons, causing alternate freezing and thawing.

"The training of Boxwood must begin from the earliest stage. Bushes must be trimmed on the top to obtain nicely shaped round plants, while pyramids must be trained quite high before they are allowed to grow in circumference. And it always must be borne in mind that Boxwood needs a lot of nourishment; feeding of small quantities of nitrate of soda will tend to keep the foliage dark green. Nitrate of soda is a dangerous fertilizer, however, and must be applied carefully as it will quickly burn the foliage. The best time to apply this fertilizer is before a storm or a rain, as then the soda which accidentally might have fallen on the foliage will be washed off immediately."

CALLICARPA. French Mulberry.
SEEDS. Sow indoors in Fall.
CUTTINGS. Soft wood in Spring. Place under bell jar or with bottom heat. Hard wood cuttings also used.

CALLUNA. Heather.
(See Vaccinium, p. 218, and Erica, p. 69; these shrubs could, no doubt, be propagated by the methods mentioned.)
SEED.
CUTTINGS. Green wood under glass.

CALOPHACA. Lentil Shrub.
SEEDS. Sow in Spring. Give good ventilation.
GRAFTING. The Laburnum (*Cytisus vulgare*) is used as stock for *C. wolgarica* in order to make graceful trees; the cions are inserted at height of six feet or more.

CALYCANTHUS. Sweet Shrub.
Calycanthus lævigatus is much sold as *C. floridus*, but it does not have the fragrance. *C. floridus* rarely seeds; *C. lævigatus* frequently produces seeds.
SEED. Sow thinly as the seed leaves are large. April.
CUTTINGS. Soft wood in Summer or hard wood in Autumn.
ROOT CUTTINGS. Bury roots in sand during Winter; toward Spring cut up into inch lengths and start in greenhouse.
LAYERS. Successful.

CAMELLIA.
CUTTINGS. Matured young wood with bottom heat. Summer.
GRAFTING. The single flowered stocks from seed or cuttings are best.

CAMPHORA. Camphor.
SEEDS. Seeds ripen in Florida in early Winter and should be sown when ripe.

CAMPSIS (Tecoma). Trumpet Creeper.
CUTTINGS. Soft and hard wood.
ROOT CUTTINGS. Of the *C. radicans*.
GRAFTING. The yellow flowered variety is grafted upon the type.

CARAGANA. Siberian Pea Tree.
*SEEDS. Keep until Spring before sowing, then soak in warm water 48 hours.
GRAFTING. *C. arborescens* seedlings are used as stocks. When five to six feet tall the stocks are worked with the weeping or pendulous sorts.
LAYERS. Easy in Summer.
ROOT CUTTINGS. Made in Spring or Winter.

CARPINUS. Hornbeam. Blue Beech.
*SEEDS. Sow as soon as ripe; seeds germinate very unevenly. Keep soil moist by covering bed. Another method is to mix seeds with moist sand and keep in flower pot or box for a year. Sow in Autumn; the seed grows the next Spring.
GRAFTING. Seedlings of *C. caroliniana* (*americana*) or *C. betulus* are used for the cut-leaved and Oak-leaved sorts.

CARYA. (Hicoria) Hickory Nuts.

*Seeds. Sow in November or in early Spring, but keep in moist sand all Winter. Difficult to get roots; use sandy soil.

Grafting. The various Caryas are often grafted on the Butternut or *C. cordiformis* (*amara*) which is potted a year previously. Veneer or splice grafts are used. Baltet mentions using terminal bud grafting. After wrapping with twine and waxing, the graft is covered with a bag made of waxed paper. The bag serves to hold the moisture, preventing evaporation from the cion.

CARYOPTERIS Blue Spiræa. Verbena Shrub.

Seeds. Pick the seeds in Autumn. Sow in February. Pot seedlings.

*Cuttings. Pot plants. Bring into heat in February. Take soft wood cuttings. They bloom by September.

CASTANEA. Chestnut. Chinquapin.

*Seeds. *C. pumila* Chinquapin. Sow seed as soon as ripe. Squirrels and mice will eat the seed, so protect them. Sow in flats rather than seed bed, or keep in moist sand during Winter, sowing in Spring to avoid the pests. Do not rely on Paragon from seed.

C. americana. Sow seeds as soon as ripe, or if kept till Spring they must be kept from drying out; if put in glass jar tightly corked they keep nicely.

Grafting. Makes them fruit earlier. The grafting is done in the Spring, but not until trees are about to burst into leaf. Seedlings are grafted by whip grafting. No method meets with satisfactory results. The Chestnut may be propagated on the Oak.

CASTANOPSIS.

Seeds. Sow seeds as soon as ripe or keep moist until Spring, then sow.

CATALPA. Indian Bean.

Seeds. Sow seeds in Spring after stratifying during Winter.

Cuttings. Made in Spring; set in nursery rows immediately.

*Grafting. *C. Bungei* (see fig. 96) and *C. bignonioides* are budded on *C. speciosa*, late in season, at height of five to six feet. When grafting use the splice graft in May. When budded, the buds are placed on both sides of the stock. Cut bud sticks early and keeps in cool, damp place until June, when bark lifts nicely.

CEANOTHUS. New Jersey Tea.

*Seeds. Sow in Spring, stratify in Winter.

Cuttings. Either ripe or green wood.

Root Cuttings. Made in Autumn, placed in flats of sandy soil to root.

Layers. During Summer.

CEDRELA.

*Seeds. Grow readily.

Cuttings. Hard wood with bottom heat.

*Root Cuttings. Cut down the growth if the first shoot by this method is not straight.

CEDRUS. True Cedars.

*Seeds. Sow in Spring. Seed is short lived.

Grafting. *C. Deodara*, the Deodar Cedar, and *C. Libani*, the Cedar of Lebanon, best grafted on seedlings of species or on *C. atlantica*, the Mt. Atlas Cedar. Use veneer graft.

Fig. 96. Catalpa Bungei. This type of tree is obtained by budding *Catalpa Bungei* upon *C. speciosa* (See page 188)

CELASTRUS. Bittersweet.
SEEDS.
CUTTINGS. Hard wood.
LAYERS. In Spring.

CELTIS. Nettle Tree. Sugar Berry. Hackberry.
*SEEDS. Sow when ripe.
CUTTINGS. Hard wood in Fall, Winter or Spring.
LAYERS. Useful when possible to make.
GRAFTING. Graft rarer roots on *C. occidentalis.*

CEPHALANTHUS. Button Bush.
*SEEDS. Grow readily. Sow Fall or Spring.
CUTTINGS. Hard wood or green wood.

CEPHALOTAXUS.
*CUTTINGS. Late Autumn under glass they root by Spring.

CERCIDIPHYLLUM.
*SEEDS. Keep moist until sown. Plants are dicœcious.
CUTTINGS. Half-ripened shoots in Summer.
*LAYERS. Cut back old plants early in Spring to force long shoots, then bend over and root. Mix some sand in soil about the plants for better rooting.

CERCIS. Judas Tree. Red Bud.
*SEEDS. *C. japonica* and *C. canadensis.* Grow from seeds. Do not bother with cuttings.
C. japonica is superior to *C. canadensis.*
LAYERS. Mound.

CHAMÆCYPARIS. Cypress. White Cedar.
(See Retinispora, which is similar.)

CHILOPSIS. Desert Willow.
CUTTINGS. Ripe wood under glass.

CHIMONANTHUS. Chinese Allspice.
SEEDS. Self seeds where seeds ripen properly or sow in warm greenhouse.
LAYERS. Spring; they root by Autumn.

CHIONANTHUS. Fringe Tree.
*SEEDS. Store seeds in damp sand. Sow in Spring. It will be a year before seedlings appear. If preferred the seeds may be kept in flats of moist sand a whole year before sowing.
GRAFTING. May be grafted on the White Ash (*Fraxinus americana*) or the European Ash (*F. excelsior*). This method is quicker than from seeds. May graft in greenhouse.

CINNAMOMUM. (See Camphora.)

CISTUS. Rock Rose.
SEEDS. Seeds germinate nicely sown in Spring.
CUTTINGS. Spring or late Summer.

CITRUS TRIFOLIATA. Hardy Orange.
SEEDS. May be stored in moist sand and sown in Spring or sown in greenhouse. For Orange and Lemon, see Orange.

CLADRASTIS (*Maackia*). Yellow Wood.
*SEEDS. Grow readily when they can be secured.
ROOT CUTTINGS. *C. tinctoria.* Roots dug in early Winter, cut into three-inch lengths, kept in damp moss in cool place and started in pots indoors or in open ground.
LAYERS. During Summer.

CLEMATIS.
SEEDS. When sown out of doors in Spring germinate in three months. Better store in sand as soon as ripe. Sow as soon as ripe in greenhouse; place under greenhouse bench.
CUTTINGS. *C. coccinea* and others. Soft wood cuttings in Summer. Internode cuttings when soft wood root best.
LAYERS. Continuous layers are useful.
GRAFTING. Large flowering sorts are grafted on *C. flammula* or *C. viticella.*

CLERODENDRON.
SEEDS. Sow when ripe.
CUTTINGS. Nearly ripe wood, rooted under glass in Summer.
ROOT CUTTINGS. *C. trichotomum* and *C. fœtidum.* In early Spring from pieces of root dug from around old plants. Use pieces two inches long.

CLETHRA. White Alder. Pepperidge.
*SEEDS. Sow in pans in sandy or peaty soil.
CUTTINGS. Green wood taken from forced plants in Spring. Use bottom heat.
DIVISION. Of clumps.
LAYERS.

COLUTEA. Bladder Senna.
*SEEDS. Seeds freely and grows readily in Fall, Winter or Spring.
CUTTINGS. Hard wood.
GRAFTED. Varieties grafted on *C. arborescens.*

COMPTONIA. Sweet Fern.
CUTTINGS.
DIVISION.

CORNUS. Dogwood.
SEEDS. Do not germinate until second year. *C. florida stolonifera, C. sericea, C. sibirica, C. alternifolia* and *C. paniculata* are propagated by seed.
CUTTINGS. All species with willowy, soft growth, such as *C. alba, C. sericea* and *C. stolonifera* are propagated by hard wood cuttings. Soft wood in Summer also.
BUDDING AND GRAFTING. *C. florida* var. *rubra* and *C. f. pendula* are grafted in Spring or budded in July on the type. *C. alba sibirica* is sometimes grafted on piece roots in Winter.
LAYERS. Continuous layers may be made of many of the shrubby sorts.

CORYLOPSIS.
SEEDS. Sow in Spring.
CUTTINGS. Half-ripe wood in Summer under glass.
GRAFTING. Perhaps can be grafted on Witch Hazel in Winter in greenhouse.
Few shoots are normally produced, so that cuttings and layers are slow.

CORYLUS. Hazelnut. Filbert.
*SEEDS. Sown in Autumn or stratified until Spring. Seed grown stock gives superior root system.
LAYERS. Purple-leaved sorts are propagated by this method. The old plants cut down and young shoots growing from this operation are layered.
GRAFTING AND BUDDING. On the type, seldom done.

COTONEASTER.
SEEDS. Sow in Autumn or stratify.
CUTTINGS. Evergreen sorts best propagated by cuttings.
GRAFTING. Deciduous sorts are grafted on Quince, Hawthorn or Mountain Ash stock.

CRATÆGUS. Hawthorn. Thorn Apple.
SEEDS. Seeds gathered in Winter and stratified germinate in two years.
CUTTINGS. Cuttings of most by either hard or soft wood.
BUDDING. The doubles, especially, are budded on almost any American species such as *C. coccinea* or *C. crus-galli.* Bud in July. Hawthorns mature early in season.

CRYPTOMERIA. Japan Cedar.
SEEDS. Sow in light sandy leafmold soil as soon as ripe. They germinate in four months.
CUTTINGS. Half-ripe wood under glass in sand in October. It takes 12 months to root cuttings.
GRAFTING. Horticultural varieties are grafted on *C. japonica.*

CUNNINGHAMIA. Chinese Fir.
CUTTINGS. Half-ripe wood in late Summer.
LAYERS.

CURRANTS. See Ribes.

CYDONIA. Quince.
CUTTINGS. Hard wood in Autumn.
ROOT CUTTINGS. Autumn or Winter. Cut up roots into pieces three inches long. Keep in cellar until Spring, then plant in rows so that top of cuttings are on level with soil.
*BUDDING AND GRAFTING. Use varieties on types, especially the strong growing Angers and Fontenay. Budding in August is commonest method.

CYTISUS. Scotch Broom, also called Genista.
SEEDS. Sown in May.
CUTTINGS. Tender shoots planted in enclosed frames or under bell jar.
GRAFTING. The stronger growing sorts are used as stocks for the smaller and trailing species.

DABŒCIA.
SEEDS. Use part peat, loam and sand.
CUTTINGS. Soft wood, any time.

DAPHNE.
SEEDS. Sow seeds as soon as ripe.
CUTTINGS. *D. cneorum.* Half-ripe wood.
GRAFTING. Graft *D. cneorum* on *D. mezereum* indoors in Winter. Use veneer grafts on stock grown in pots. Rarely grafted.
LAYERS. In the Spring, especially *D. cneorum.*

DAVIDIA.
SEEDS. Sow in Spring.
BUDDED. Possibly can be budded on *Cornus florida.*

DECUMARIA. American Climbing Hydrangea.
CUTTINGS. Young plants grow slowly at first.
LAYERS.

DEUTZIA.
SEEDS.
*CUTTINGS. Ripened wood and half-ripe wood taken from plants in greenhouses, or soft wood in Summer. Use hard wood for *D. crenata* varieties; half-ripe wood for *D. Lemoinei* and *D. gracilis,* its varieties.
LAYERS.

DEWBERRIES.
ROOT CUTTINGS. See Blackberry.

DIERVILLA. Weigela.
SEEDS. Not difficult to raise, but do not come true.
*CUTTINGS. Half-ripened shoots in Summer. Hard wood cuttings root readily.
LAYERS.

DIMORPHANTHUS.
SEEDS. Sow as soon as ripe. Gather soon after ripening, for birds will get them. Sow immediately.
ROOT CUTTINGS. Dig up the plants in April or May. Cut roots in three-inch lengths and set in rows.

DIOSPYROS. Persimmon.
Some trees are staminate, others pistillate, others perfect flowered.
SEEDS. Sow as soon as ripe or stratify until Spring.
CUTTINGS. Half-ripened wood.
GRAFTING. Graft named sorts on *D. virginiana*, the seedlings, of which often make plants large enough for budding the first year.
BUDDING. A perfect flowered sort budded on a seedling insures fruiting.

DIRCA. Leather Wood.
SEEDS. Ripen early. Sow when ripe.

ELÆAGNUS. Oleaster. Wild Olive.
*SEEDS. Sow seeds as soon as ripe or place in damp soil until October; then sow out of doors. Certain plants from seed produce no berries.
CUTTINGS. Hard wood and half-ripe wood for variegated sorts.
LAYERS. In May.
GRAFTING. *E. umbellata* is used as stock for other sorts. *E. Simonii* is grafted on *E. longipes* because it blooms so late that it seeds poorly.

ELSHOLTZIA.
CUTTINGS. Soft wood in greenhouse in January or February.

ENKIANTHUS.
CUTTINGS. Hard wood under glass Fall; half-ripe wood in Summer.
LAYERS. In Spring.

ERIOBOTRYA. Loquat Tree. Japanese Plum.
SEEDS. Sow as soon as ripe. Keep damp at all times.

EUCALYPTUS. Blue Gum.
SEEDS. Very rapid grower. Sow in May or June in California.

EUCOMMIA. Hardy Rubber.
SEED.

EUONYMUS. Burning Bush. Spindle Tree. Wahoo.
SEEDS. All sorts except *E. alatus* are said to grow well.
CUTTINGS. *E. japonicus.* Grow plants in rich soil for propagating. Half-ripe wood Midsummer. Hard wood cuttings may also be used.
LAYERS. Evergreen species readily propagated by this method.
GRAFTING. *E. americanus.* Graft on *E. atropurpureus* or *E. europæus* to make its display of berries more attractive.

EXOCHORDA. Pearl Bush.
*SEEDS. Grow easily. Does not grow readily from cuttings or layers.
CUTTINGS. Soft wood best in Summer.
GRAFTING. Grafted by splice graft on own roots.
LAYERS. In Summer.

FAGUS. Beech.

*SEEDS. Mix nuts with sand, keep cool till Spring or sow in Autumn.

GRAFTING. Blood-leaved, Tricolor, Weeping, Cut-leaved, grafted on seedling of type in early Spring.

INARCH. May be inarched in July by setting pots of seedlings around a specimen and uniting the branches.

LAYERS. Weeping varieties are layered.

FICUS. Fig (*F. carica.*)

CUTTINGS. Hard wood cuttings in early Spring.

GRAFTING. Only practiced when varieties are poor growers; then graft on type.

FIG. (See Ficus.)

FONTANESIA.

CUTTINGS. Summer under glass.

FORSYTHIA. Golden Bell.

*CUTTINGS. Hard wood root very easily in October. Soft wood in Summer.

GRAFTING. *F. suspensa* is grafted on *F. viridissima* to get height.

LAYERS. Very easily propagated by this method.

FRAXINUS. Ash.

*SEEDS. Jenkins writes:

> White Ash seed will seldom grow well the first season after planting, unless subjected to special treatment. There is a theory in regard to many seeds difficult to propagate, that a gummy, resinous, or oily epidermis covers them, interfering with the action of the air necessary to produce germination. Excellent results have followed the immersion of such seed in an alkali or in acetic, or dilute sulphuric acid. Care must be used, however, that the acid or alkali, does not destroy the integuments of the seed in addition to this air-proof covering.

LAYERS. Good for *F. Ornus.*

GRAFTING. The Green, Golden-weeping, Golden-barked, etc., are grafted or budded on *F. excelsior,* the European Ash. Bud in July, low for all but weeping sorts.

GARRYA.

SEEDS. The plants are dicœcious.

CUTTINGS. Half-ripe best.

GELSEMIUM. Carolina Jasmine.

A greenhouse vine in the North.

CUTTINGS. Hard wood in Spring.

GINKGO. Maidenhair Tree.

*SEEDS. Sow in Spring, but keep moist through the Winter.

GRAFTING. Use male trees only; the female trees produce ill-smelling fruits. Graft on seedlings. Also budded (see fig. 97).

GLEDITSCHIA. Honey Locust.

SEEDS. Scald and sow in Spring.

GRAFTING. *G. triacanthos* var. *inermis,* the Thornless Honey Locust, is grafted on seedlings of the type. This type is better for cities because it is less offensive.

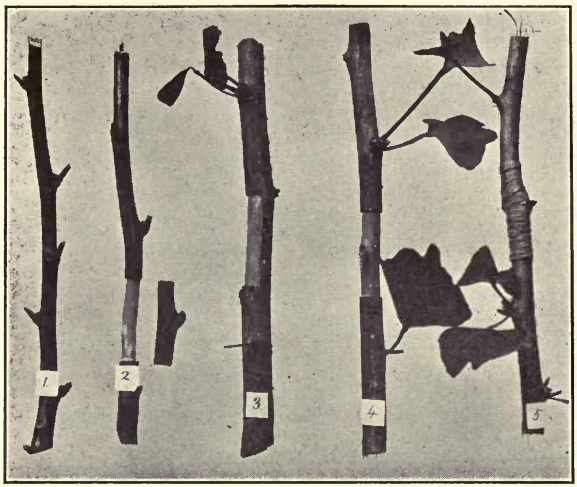


Fig. 97. Budding the Ginkgo. 1, A bud stick. 2, Ring bud removed. 3, Patch bud removed. 4, Stock ready for ring bud. 5. Ring bud applied to stock, showing the careful wrapping with raffia (See page 123)

GOOSEBERRY. (See Ribes.)

GORDONIA. Loblolly Bay.

CUTTINGS. Half-ripened wood. Use sand and water method in warm house in full sun or place in greenhouse propagating bench.

LAYERS. Successful.

GRAPE. (See Vitis.)

GYMNOCLADUS. Kentucky Coffee Tree.

*SEEDS. Scald and sow in Fall.

CUTTINGS. Hard wood.

HALESIA. Snowdrop Tree. Silver-Bell.

SEEDS. Sow seeds as soon as ripe, otherwise they take two or three years to germinate.

CUTTINGS. Green wood from plants grown indoors.

ROOT CUTTINGS. Spring or Autumn.

GRAFTING. Most of genera of this family may be grafted on *H. tetraptera*. (*H. carolina*.)

HALIMODENDRON. Silver Leaf.

SEEDS. If left on the plants over Winter and sown in the Spring they will germinate nicely.

CUTTINGS. Root well.

LAYERS. Root slowly.

GRAFTING. Use *Caragana arborescens* as a stock.

HAMAMELIS. Witch Hazel.

SEEDS. Joseph Meehan gives the following notes:

> The shrub flowers in October and November, and the seed pods form then, but do not ripen until the next August or September. The pods are to be gathered then, when one or two by bursting open show the time has come for it. These pods are placed on a tray and set in the sun, that they may open at once. But they must have a sieve set over them, as when the pods open they eject the seeds, sometimes to quite a distance. This is not known to all who attempt to secure the seeds, and many are disappointed in finding themselves short of the seeds they expected. Seeds sown in Spring, and covered lightly, usually grow very well. Because of the shooting character of the seeds this shrub should be called the Revolver Shrub. It takes five years to obtain salable plants from seeds.

GRAFTING. The Japanese species are grafted on the American, indoors.

HEDERA. (See pp. 33, 69).

HIBISCUS. Rose of Sharon. Althæa.

SEEDS. Not true to color from seeds.

CUTTINGS. Hard wood in early Fall, stored until Spring.

LAYERS. Mound layering is often used.

GRAFTING. Graft named varieties on seedlings.

HICORIA. (See Carya.)

HIPPOPHAË. Sea Buckthorn.

SEEDS. Sow as soon as ripe. Keep plants until they flower to determine sex, for the plants are dicœcious.

CUTTINGS. Hard wood does not root well.

LAYERS. Best method. Be sure to propagate both male and female plants.

ROOT CUTTINGS.

HOVENIA.

SEEDS. Grows readily from seeds.

CUTTINGS. Half-ripe wood in early Summer.

LAYERS. Late Spring.

HUCKLEBERRY. (See Vaccinium.)

HYDRANGEA.

SEEDS. Many varieties seed freely.

*CUTTINGS. Hard wood cuttings root readily in Spring. Green wood cuttings in Summer under glass. The harder wooded sorts are best propagated by green wood cuttings. Climbing sorts are difficult to root. *H. quercifolia* use smallest wood for hardwood cuttings in October.

LAYERS. Cut down the bush the previous season to force the production of many shoots. (See p. 98.) Successful with *H. quercifolia*.

GRAFTING. Use splice or cleft graft. May be made in Spring and placed in coldframe. Roots collected during shipping season. Pieces of roots are all that are necessary. Grafted stock is stronger and healthier.

HYPERICUM. St. John's Wort.

*SEEDS. Very fine; sow carefully.

*CUTTINGS. Green wood cuttings in September.

DIVISION OF PLANTS. Hardy species.

ROOT CUTTINGS. Spring.

IDESIA. Japan Cherry.

SEEDS. Japanese seedsmen offer seeds.

CUTTINGS. Soft wood cuttings.

ROOT CUTTINGS. Make in Autumn, plant in Spring.

ILEX. Holly.

SEEDS. Propagate plants of both sexes. Joseph Meehan writes:

"The commoner sorts are propagated by seeds. As there is an abundance of seed in the florists' stores at Christmas, a supply should be collected then by those who wish to sow the plant. This applies to both the native, northern form, *Ilex opaca*, and the English species, *I. aquifolium*.

"Holly seeds do not germinate under a year or more. The way to proceed with them is to mix them with sand in a box as soon as they are ripe or in early Winter. The box may be kept in a shed or building through the Winter; when Spring comes wash the seeds free of pulp, as if allowed to remain the pulp is apt to cause fungus to form, to the detriment of the seeds. After the seeds are cleaned they should be mixed with fresh, clean sand and again be placed in a box, there to remain until Autumn, when they should be sown. The seedlings may be expected in late Spring.

"It is better to treat the seeds as recommended than to sow them as soon as ripe as some do. Such a method renders a bed useless for a whole season, and, worse, it requires weeding and care."

CUTTINGS. Deciduous sorts are propagated by hard wood cuttings, especially *I. crenata*.

LAYERS. Cut down plants to force shoots; then make little upward cuts in stems and insert a pebble to keep each cut open. Heap sand around the plants, covering the shoots all but their tips. When layered in Spring they root by Autumn, but they should be allowed to remain for two Summers.

BUDDING. Budded in Spring from starting buds; or in Autumn from dormant ones. This method is used in order to insure a plant which will produce berries abundantly. *I. opaca*, the American Holly, is an excellent stock, but the seedlings of *I. aquifolium* being easier to obtain, this species is also used.

GRAFTING. Veneer grafting in August under glass. Select short shoots of berry-producing branches for use as cions.

INDIGOFERA. Indigo Plant.

CUTTINGS. Green wood.

ITEA. Willow Shrub.

*SEEDS. Can be grown from seed.

CUTTINGS. Hard wood.

DIVISION.

JASMINUM. Jasmine. Jessamine.

CUTTINGS. Nearly mature wood under glass. Layers and suckers.

LAYERS. Very successful.

JUGLANS. Walnuts and Butternut. (See fig. 98.)

SEEDS. Most of the Walnuts should be treated much as Joseph Meehan advises for the English Walnut, *Juglans regia:*

"The nuts of the English Walnut require treatment different from that accorded many other kinds. It won't do in the North to sow them in Autumn. As a rule they rot when so treated. They should be kept indoors, in a rather cool place, mixed with slightly damp sand, and then sown outdoors in Spring, when every one may be expected to grow. Seedlings from imported nuts, and even those from home grown trees, are apt to lose their terminal buds when young. It is.

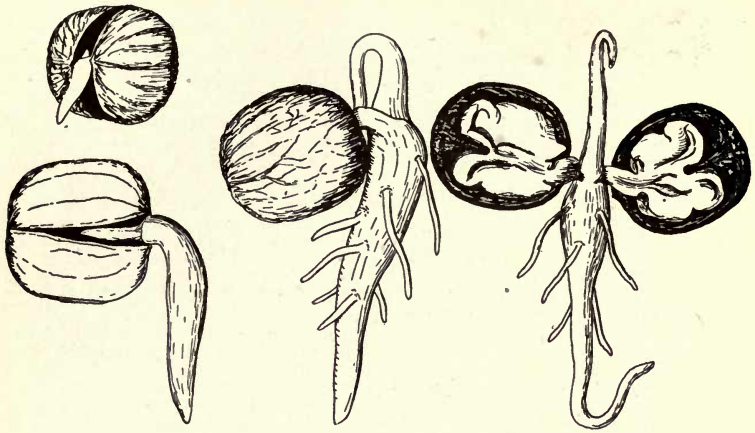


Fig. 98. Germination of an English Walnut

JUGLANS—Continued

therefore, wise to give them some protection, such as forest leaves provide, in an endeavor to preserve them. Another good plan is to let seedlings remain in their seed beds for two or three years before transplanting them; one protects the other in this way; they are more easily preserved in Winter, and the close growth in the beds causes them to make height instead of branches, all in the interest of the grower.

"There are many varieties of the English Walnut, the thin shelled, the early fruiting and a number of others, all differing in their nuts from the type. These it is not safe to rely on as coming true from seed. Of a hundred nuts, of any one of them, while some might be the same as the parent, many would not.

GRAFTING AND BUDDING. *Juglans cinerea*, Butternut, can be grafted by terminal bud graft. *Juglans regia*, English Walnut, is budded on Butternut or Black Walnut in Summer, when the sap is flowing strongly.

JUNIPERUS. Juniper. Red Cedar.

SEEDS. Very hard. Should be softened, according to Fuller, by soaking in potash water for several days. Stocks of *J. virginiana*, the Red Cedar, for budding are raised, according to Marinus Van Kleef as follows:

"Plenty of sand must be used in preparing the seed beds, for mold is one of the diseases which frequently attack the Juniperus. Not too much moisture should be applied to the seed, while the frame must be aired continually, except in wet, foggy weather, when it is advisable to keep the frames closed. Painting the glass in the sashes with lime, is of course also in this case a necessity.

JUNIPERUS—Continued

"When the little plants are ready to be planted in the nursery, they are set in beds, in order to make it easier to keep them free from weeds. They are planted close together, to insure a straight, smooth growth. In December they are potted, and then placed in a frame. Before potting, however, they must be trimmed, and all the small branches removed from the bottom, about 3 inches to 4 inches up the stem. Then by the time they are grafted, the stems are healed nicely. Grafting is done in March. The cions are usually very thin, but that does not matter. If the cion is very long, it can be cut back a little."

CUTTINGS. Grow readily from soft, unripe wood in greenhouse or from more mature wood in frames. It takes two years for some to root. (See fig. 75, also p. 73).

GRAFTING. See paragraph above, on seeds, for raising stocks. Van Kleef then continues:

"The little plants in the pots must be kept rather dry at all times during the grafting process, to prevent molding. They are aired every morning for a few minutes in the greenhouse, and the drops of water which cover the plants must be removed by sliding your hand over them very gently. If mold appears in some places it must be cut away immediately; dying plants also should be removed. In about three weeks the plants are examined and changed around. Usually a large space is gained, as plenty of dead plants have to be thrown away. A small piece of the top of the plant is cut off, when they are changed around, as the cion of the Juniperus needs much light. It usually takes six or seven weeks for the cions to grow on to the stems, then they are brought out into the frame.

"The first week in the frame only a little air is given every morning; after that the plants are hardened off gradually, so that the first part of June they can be planted out in the nursery.

"In my experience with American nurserymen, I always have noticed that few of them believe in using sticks with coniferous evergreens, so as to train them into beautiful, straight plants. And even when they do use sticks, the stick is usually tied to the plant, instead of the plant being tied on to the stick. There is, of course, a way to grow straight conifers without the use of sticks; that is, by trimming them a certain way. This is done by cutting back the top of the plant almost to the old wood, leaving one of the small side branches for a top. However, this method takes several years longer to produce coniferous evergreens of commercial size.

"In Holland, after the planting season is over, the nurseryman begins to set out his Bamboo sticks, and usually starts with the small evergreens which were propagated during the last Winter. Then for the next two or three years the small Junipers are not disturbed, except for root pruning, trimming and tying them on to sticks.

"It is the aim of every Holland nurseryman to secure as straight and high an evergreen during the first few years as he can, by tying up the tops and trimming them severely on the sides. After a certain height is reached they are not trimmed so severely on the sides any more, but are allowed to fill out somewhat. Never leave a conifer to become too thick at the bottom, as it soon gets the shape of a Pineapple."

KALMIA. Mountain Laurel.

SEEDS. Sow in Spring in a mixture of sand, peat and loam in pans or flats and keep in greenhouse or coldframe. Transplant seedlings early into other flats. Do not put out in open for a year.

CUTTINGS. Most species, except *K. latifolia*, grow nicely from half-ripened wood cuttings.

LAYERS.

KALMIA—Continued

GRAFTING. *Kalmia latifolia* varieties are side grafted on seedlings in greenhouse.

Most American nurserymen collect plants from the wild.

KERRIA. Corchorus. Globe Flower.

*CUTTINGS. Young wood under glass in Summer, also hard wood.

KŒLREUTERIA. Varnish Tree. Bladder Pod.

SEEDS. Produced freely. Stratify.

ROOT CUTTINGS. Grow readily.

LABURNUM. Golden Chain.

SEEDS. Easy, sow in Spring. Seedling flowers are apt to be poor.

CUTTINGS. For varieties.

GRAFTING. Varieties and hybrids on seedling stock.

LAYERS.

LAGERSTRŒMIA. Crape Myrtle.

SEEDS. Obtain from the South. The various colors come true.

CUTTINGS. Hard wood, except the white varieties, in April. Green cuttings may be made in the greenhouse in Summer.

ROOT CUTTINGS. Most successful method with the white variety.

LARIX. Larch. Tamarack.

*SEEDS. Keep dry during Winter. Sow in Spring. Shade seedlings.

GRAFTING. Whip or cleft graft out of doors; veneer graft indoors. This latter method is best. Use European Larch, *L. europæa*, mostly.

LAURUS. Sweet Bay. Laurel.

SEEDS. Sow as soon as ripe, then they will germinate in a few weeks.

CUTTINGS. Half-ripe wood placed under glass in Wardian case.

LEDUM. Labrador Tea.

SEEDS. Sow in Spring.

LEMON. (See Orange.)

LESPEDEZA. Bush Clover.

SEEDS. Successful with *L. bicolor*.

CUTTINGS. *L. Sieboldii*. Half-ripened shoots in Summer. Top dies down in Winter.

LAYERS. *L.* (*Desmodium*) *bicolor*. In Summer. Take up in Autumn and protect for Winter.

DIVISION OF PLANTS.

LEUCOTHOË.

SEEDS. Sow in sphagnum moss and sand; prick off in flats, and in early Spring plant out of doors.

CUTTINGS. Half-ripe wood cuttings placed in sand with bottom heat.

LAYERS. Underground runners.

LEYCESTERIA.

SEEDS.

CUTTINGS.

LIBOCEDRUS. Incense Cedar.

SEEDS. Sow in Spring.

CUTTINGS. Late Summer in greenhouse, root slowly.

GRAFTING. Graft on *Thuya* and *Chamæcyparis*.

LIGUSTRUM. Privet.

SEEDS. Some may be raised from seed but Regel's Privet being a variety of *L. Ibota* does not come true.

CUTTINGS. Soft wood cuttings in Summer rooted in greenhouse. The prunings from the hedge cut into foot lengths root easily in the Spring.

LINDERA. (See Benzoin.)

LIQUIDAMBAR. Sweet Gum. (See fig. 99.)

*SEEDS. Stratify as soon as ripe. May not grow until second year. Require moist seed bed, therefore, water in the dry Summer.

Fig. 99. The seed ball of the Sweet Gum.

LIRIODENDRON. Tulip Tree. White Wood.

*SEEDS. Sow as soon as ripe in Autumn in a light soil with some leafmold in it. Young plants make many long succulent roots, so they should be transplanted for several succeeding Springs. Usually less than half of the seeds grow.

GRAFTING. Sometimes grafted or budded on seedlings.

LONICERA. Honeysuckle.

SEEDS. Sow in Autumn or stratify.

CUTTINGS. Either hard or soft wood. Soft wood rooted under glass. especially *L. Alberti* and *L. hispida.*

LAYERS. Put down compound layers in Autumn or early Spring.

LYCIUM. Matrimony Vine.

SEEDS. Sow seeds as soon as ripe.

CUTTINGS. Hard wood, one year old. Soft wood in Summer.

MACLURA. (Toxylon) Osage Orange.

SEEDS. In Spring soak in warm water for forty-eight hours, then sow.

CUTTINGS. Green wood indoors.

MAGNOLIA.

*SEEDS. Jenkins writes:

After the red seeds of Magnolia are gathered from the pods, put them in a tub, or bucket, with enough water to barely cover them. Stir occasionally. In a few days the red, pulpy covering will be softened and may be rubbed from the black seed, or seed proper, in the hands; or, place the seeds in a coarse sieve and rub the pulp through the meshes into a running stream. The meshes of the sieve must be fine enough to retain the black seed. Then mix lime or wood ashes with the seed to cut the oily matter that appears to interfere with germination.

Joseph Meehan writes:

Sow the seeds in early Spring, keeping them in a moist condition from the time they are gathered. Some sow the seeds in Autumn, some after they are gathered, placing a covering of leaves over them for the Winter. But keeping them in slightly damp soil all Winter and sowing early in Spring is a sure way; of course, watching the seeds right along through the Winter to see that everything is right.

Layering. The old way of layering is the most solid of all. This is the time to cut back almost to the ground the stocks desired for layering purposes. Take some real heavy plants and cut them back to but a few eyes above the ground. This will cause the growth of strong, young shoots, which are just the sort needed for layering. The work should be done as soon as the shoots are of length enough to permit of it. If put down early, they will be nicely rooted by Fall, but should not be cut off from the parent plants before Spring. Old hands at propagating aver that but little is lost by allowing the layers to remain undisturbed for two years. In this way, too, the old plants are permitted to have a year's rest from layering, strengthening them, as the cutting down and layering the same plants year after year weakens them. This will lead propagators to have two sets of plants for layering, working one set one year, the other the next, which is much the better plan.

CUTTINGS. Half-ripe under glass.

BUDDING. Use *M. acuminata*, the Cucumber Tree, or *M. tripetala*, the Umbrella Magnolia, as a stock. For standards the bud is inserted at height of five to six feet.

GRAFTING. *M. tripetala* better, because of abundance of fibrous roots which make transplanting safer. Performed under glass. Side cleft grafting is preferred. To increase the size of *M. glauca* it is successfully grafted on some larger growing species.

INARCHING. Successful.

*LAYERING. Low growing sorts especially *M. Soulangeana*, *M. Lennei*, *M. stellata*.

MAHONIA. Oregon Grape.

SEEDS. Grow easily if sown soon after ripening.

CUTTINGS. Half-ripe wood under glass.

MEDLAR. (See Mespilus.)

Fig. 100. Teas' Weeping Mulberry (See page 203)

MELIA. Pride of India. China Tree.
SEEDS. Rather difficult to raise. Sow seeds as soon as ripe. *M. Azedarach* var. *umbraculiformis* breeds true to seed.
CUTTINGS. Hard wood.
MESPILUS. Medlar.
GRAFTING. Best use *Cratægus* as stock, but seedling Medlar and Quince can be used.
MISTLETOE. (See Phoradendron.)
MORUS. Mulberry. (See fig. 100.)
*SEEDS. Wash and keep cool and dry until Spring; then sow; they germinate in several weeks. They may be sown in the Autumn.

MORUS—Continued

CUTTINGS. The Russian type, *M. alba*, roots easily; the wild one, *M. rubra*, and Downing's Everbearing do not.

*GRAFTING. *M. rubra* and *M. alba* make the best stocks for Downing. Weeping varieties are grafted at height of five or six feet above the soil. Grafting is practiced in early April. Root grafting in Winter may also be used.

MYRICA. Wax Myrtle

SEEDS. Grow slowly. Sow in Spring.

SUCKERS. Especially *M. Gale.*

NANDINA. Heavenly Bamboo.

SEEDS. Obtained from California. Germinate in three months.

NECTARINE.

Same stock and method of treatment as for Peach, page 137.

NERIUM. Oleander.

CUTTINGS. Hard wood. Soft wood rooted in water easily. Take cuttings after flowering.

LAYERS. Chinese layers are successful.

NEVIUSIA. Snow Wreath.

This is a *Spiræa* without petals.

CUTTINGS. Green wood cuttings under glass.

DIVISION. Successful.

NYSSA. Sour Gum. Tupelo.

*SEEDS. Collect in Autumn, free of pulp and sow immediately; or store in damp sand during Winter. Sow seeds in flats, they take a year to germinate.

GRAFTING. Weeping form grafted on type.

The trees are difficult to transplant and should be raised in pots.

OLEA. Olive. (See Osmanthus.)

CUTTINGS. From Fuller we learn:

> In warm climates, where the Olive flourishes, the cuttings are planted in the open ground in the Autumn. In European countries large truncheons or cuttings are used instead of those of moderate size or lengths, but for no better reason than because it is the general practice or custom. Chips cut from an old Olive tree stem will readily produce sprouts if planted in a warm soil and kept moist; in fact, the entire surface of this tree will produce adventitious buds very freely, if placed in a position to receive heat and moisture.

ORANGE.

BUDDING. Indoors. May be budded at any season when they are making active growth. Use round bud wood rather than flat, and propagate from bearing trees.

OREODAPHNE. Umbellaria. California Laurel.

SEEDS. Keep moist from time they are collected until sown.

OSMANTHUS. Sweet Olive. Also called *Olea fragrans.*

SEEDS. Not easily obtainable.

CUTTINGS. Half-ripe wood late in Summer or Fall.

BUDDING. May be budded on Privet.

OSTRYA. Ironwood. Hop Hornbeam.

SEEDS. Sow as soon as ripe or stratify.

GRAFTING. May graft the varieties on common species.

OXYDENDRON. Sorrel Tree.
SEEDS. Sow in frames. Keep shaded and moist until they germinate. The plants are apt to be rather difficult to grow the first year.
LAYERS. Very slow to grow.

PACHYSANDRA.
CUTTINGS. Soft wood.
DIVISION OF RHIZOME.

PÆONIA. Shrubby sorts, *P. Moutan.*
CUTTINGS. Taken with heel in Summer and placed in cool greenhouse.
LAYERING. Layers require about two years to root.
GRAFTING. Root grafting. Use the large fleshy roots for stocks and graft by the side graft. Graft in early Autumn and store for Winter. Both root and stock grafting may be used. They may also be grafted on the herbaceous sorts; use a splice or cleft graft.

PALIURUS. Christ's Thorn.
SEEDS. Stratify or sow as soon as ripe.
ROOT CUTTINGS. Store in moist sand during Winter.

PARROTIA.
CUTTINGS. Green wood under glass.

PASSIFLORA. Passion Flower.
*CUTTINGS. Take growths from January to April; place in warm propagating bench, shaded and moist. Pot in loam, peat and sand.
LAYERS. Compound layers used.
ROOT CUTTINGS.

PAULOWNIA. Empress Tree.
*SEEDS. Sow in Spring. Seedlings damp-off easily.
CUTTINGS. Green wood under glass
*ROOT CUTTINGS. Cut into three-inch lengths. plant outdoors or in greenhouse in the Spring.
LEAF CUTTINGS. Petioles cut short, leaves placed in sand covered with a bell jar.

PAVIA. Dwarf Buckeye. Dwarf Horse Chestnut.
SEEDS. Very easily grown if sown soon after ripening.

ERIPLOCA. Grecian Silk.
*CUTTINGS. Soft wood vine under glass.
*LAYERING. Slow. Easiest method.

PHELLODENDRON. Cork Tree.
SEEDS. Freely produced, and germinate readily when sown in Autumn.
GRAFTING. The Chinese Cork Tree (*P. amurense*) is grafted on *P. japonicum* since *P. amurense* is much superior in corkiness of bark.
ROOT CUTTINGS. Spring.
LAYERS.

Fig. 101 Seed vessels of *Paulownia tomentosa*

PHILADELPHUS. (Erroneously called Syringa). Mock Orange.
SEEDS. Often self sow. May be sown in Spring.
CUTTINGS. Make from hard wood in Autumn; set in Spring for *P. coronaria* and *P. grandiflora*. Soft wood for Lemoine's varieties and yellow leaved sorts.

PHORADENDRON. Mistletoe.
SEEDS. Joseph Meehan writes:

"It takes patience to increase the Mistletoe, but those who wish to try it may proceed thus: Take the berries and press them to a branch, the under side preferred, until they burst. They are so viscid that they will adhere to the bark, but that birds shall not disturb them, tie them fast with a piece of muslin. Do not be impatient to see the plants, for nothing will be seen for a year, and then only a swelling of the bark. But this swelling indicates that all is well, and the next season some growth may be expected. There is a difference of opinion as to the cutting of a notch in the bark to hold the berries. Late authorities say it is better not to do so. The natural way finds no slit bark, and with the bandage of muslin to hold the seed in place, there can be no necessity for notching the branch.

"The Mistletoe is a parasite, living off the juices of the trees it attaches itself to. There are two sorts that come to our markets; the old Mistletoe of Europe and that of our own country. The European one is *Viscum album*, ours, *Phoradendron flavescens*, both being of the same general character.

"In Europe its host trees are generally the Apple, Poplar, Hawthorn, Linden, Maple and Mountain Ash; rarely the Oak. In our country it is found on Oaks, Elms, Apples, Locust, Hickories, etc.; and it is always interesting wherever found growing."

PHOTINIA. Chinese Christmas Berry.
SEEDS. Stratify.
CUTTINGS. Ripened wood.
LAYERS. Roots readily from layers covered in Spring.
GRAFTING. Worked on Hawthorn, Apple roots or Quince stock.

PHYSIANTHUS.
CUTTINGS. Made in late Winter.

PHYSOCARPUS. Ninebark.
SEEDS.
CUTTINGS. Hard wood or green wood.

PICEA. Spruce.
SEEDS. Keep dry and cool through the Winter. Sow in Spring. In raising seedlings of *Picea pungens*, the Colorado Blue Spruce, many of the plants are not of the desired deep blue. These must be discarded because even from the best plants the seed does not come perfectly true.
CUTTINGS. The dwarf forms are especially easily grown from cuttings.
GRAFTING. Seedlings of the Norway Spruce, *P. excelsa*, make the best stocks because of their adaptability to soils, hardiness and good growth. Veneer grafting in Spring or August in the greenhouse.
INARCHING. Seedlings of *P. pungens* are potted and plunged in the soil at base of growing Koster's Blue Spruces. The seedlings can then be inarched by the tongue inarch (see p. 125) and tied with raffia. Do this in Summer.

PICKNEYA.
SEEDS. Grow readily, but the plants are not hardy.

PIERIS.
SEEDS. (See Andromeda.)
CUTTINGS. Nearly ripe wood. August, under glass.

PINUS. Pine.
SEEDS. Sow in beds, about three feet wide so that they may be weeded. After growing one year transplant them just as buds are swelling. Shade the young plants early in growth, but gradually allow the beds to have the full sunlight, else damping-off will occur. Keep them sparsely watered.
GRAFTING. Veneer grafting is used to work various rarer varieties on the type. The plants may be potted and grafted indoors. In grafting out of doors the terminal bud graft is best used. (See p. 120.) Fuller writes that the two- and three-leaved sorts, *P. sylvestris*, *P. Mughus compacta*, *P. pyrenaica* and *P. densiflora*, should be used in grafting varieties of the same number of needles. The Austrian Pine (*P. nigra* var. *austriaca*) may be used as a stock for the Western Pines (*P. ponderosa*, *P. Coulteri*, and *P. Sabiniana*), all of which have coarse grained wood. The rapid, free growing, three-needle sorts are preferred for the others; for example, the Red Pine (*P. resinosa*) is the best stock for allied species and varieties. The White Pine (*P. Strobus*) a five-leaf sort, is best used for the other five-leaved species, *P. flexilis*, *P. excelsa*, *P. Cembra*, and *P. Mandschurica*.

PLATANUS. Button-wood. Plane Tree. Sycamore.
*SEEDS. For the Oriental Plane only. Sow in Fall, expose to freezing.
CUTTINGS. Hard wood taken in Autumn. Occasionally *P. orientalis* will root, although more difficult than *P. occidentalis*.

POMEGRANATE. See Punica.

POPULUS. Poplar.
*SEEDS. Sow as soon as ripe. Plant shallow, water if soil becomes dry.
*CUTTINGS. Hard wood root easily, one or two-year-old wood used.
BUDDING AND GRAFTING. Varieties are worked on rapid growing species.

POTENTILLA. Shrubby Cinquefoil. Five Finger.
SEEDS.
CUTTINGS. Mature wood taken in Autumn.

PRUNUS. Propagation of ornamental species only.
*SEEDS. Good for species and stocks. See under Peach and Plum, p. 137 and 140.
CUTTINGS. Mature wood used for some ornamentals and European Plum, use long cuttings.
ROOT CUTTINGS. Plants from cuttings are apt to sucker easily.
BUDDING. Shield bud on seedling stock. *P. Pissardii* may be budded on any plum stock.

Prunus. Amygdalus. Almond (see fig. 102).
*BUDDING AND GRAFTING. The ornamental horticultural varieties are budded on the Peach or the Plum. The Plum is usually preferred because it is not attacked by borers and succeeds well in a clay soil.

PRUNUS—Continued

If the Plum is not a strong grower, however, there is danger of the roots being inadequate for the best development of the Almond. *P. Amygdalus* var. *nana* is best budded at a height of three feet upon Plum. (See also Plums, p. 140, and Peaches, p. 137).

ROOT CUTTINGS. *P. A. nana* is successfully propagated by cuttings of large roots made in Autumn stored in damp moss until Spring.

Prunus. Cerasus. Ornamental Cherries.

BUDDING. Use the Mazzard stock, usually, especially for budding *P. Cerasus Sieboldii rosea plena* (Jap. Weeping Cherry) and *sir ensis plena* (Chinese Double Flowering Cherry). For weeping sorts, two buds; for others one is sufficient to make a head. Careful attention to heading back the growth of bud will help to make greater symmetry. Spring grafting is not so successful. (Refer also to Cherries, p. 136.) *P. Mahaleb* is good for dwarfing the ornamentals.

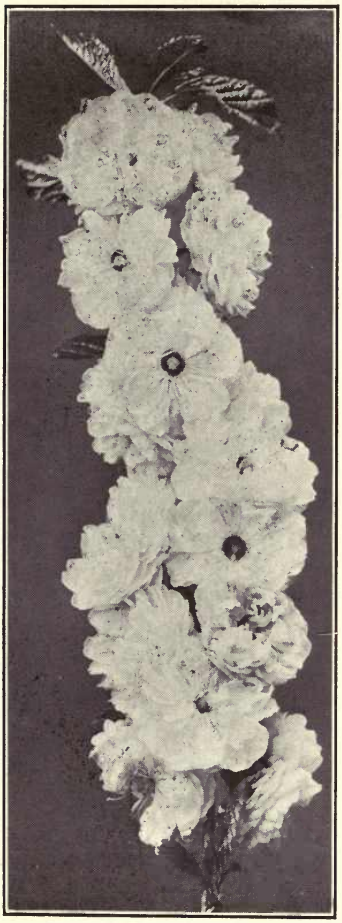


Fig. 102.—Double flowering Almond. The cut shows a characteristic branch of *Prunus triloba* var. *plena*. This variety when grown as a standard and worked upon the Plum is often short-lived. It is best propagated by layering or root grafting. It makes an excellent subject for forcing, but is also used for gardens (See page 207)

PSEUDOLARIX. Golden Larch.

SEEDS. Obtainable from Japan.

GRAFTING. Graft on Larch outdoors, or better still, in the greenhouse. For indoor grafting pot plants in Spring so that they are established by Autumn and can be stored until late Winter, then brought into heat to start growth. When the buds swell, it is time to graft. Cut cions in Winter and hold dormant in cool conditions.

PSEUDOTSUGA. Douglas Spruce.

*SEEDS. Generally so propagated. Sown in Spring. Eastern growers should demand Eastern or Colorado seed, as the California seed is tender.

GRAFTING. The weeping form is grafted on the common stock.

INARCHING. Used on weeping form.

PTELEA. Hop Tree.
*SEEDS. Sow in Autumn or stratify in sand.
LAYERS. Varieties of Hop Tree are easily layered.
GRAFTING AND BUDDING. Graft under glass or bud out of doors on seedlings. Golden form grafted on the type.

PTEROCARYA. Winged Walnut.
*SEEDS. Sow in Autumn or stratify.

PTEROSTYRAX. Wistaria Tree.
SEEDS. Ripen in Autumn; sow immediately or in Spring.
CUTTINGS. Green wood under glass, in Summer.
GRAFTING. May be grafted on seedling *Halesia.*

PUERARIA. Kudzu Vine.
CUTTINGS.
LAYERS.

PUNICA. Pomegranate.
CUTTINGS. Hard wood.
GRAFTING. May be grafted on wild type.

PYRUS. Apples, Pears, Crabs.
Ornamental species only; commercial fruit discussed on pp. 135-136.
SEEDS. The botanical species *P. coronaria, P. ioensis,* etc. come true.
BUDDING. For *Pyrus coronaria* and Bechtel's Double Flowering Crab. Mid-July or later on common Apple stock. Should be budded near end of growing season. When budded earlier the union does not take place so well.

Pyrus Malus. Apple.
GRAFTING. The commonest stock for the Apple is the wild apple of Europe, but for the Siberian Crab varieties *P. prunifolia, P. angustifolia* or *P. coronaria* are used. For dwarfing the Apple, Paradise and Doucin stocks are used, both of which are small types of *P. Malus.* (See p. 136.)

QUERCUS. Oak.
*SEEDS. Joseph Meehan writes:

Many Oaks are of the class which commence to grow as soon as the acorns fall, and these sorts require sowing within a week or so after they are ripe. In this class are the White Oak, Chestnut Oak, Rock Chestnut, Chinquapin, and maybe others. If not sown within a week or two after falling they will not grow, unless in the meantime they have been in a damp place. The trouble is, that they either lose vitality by drying up or the radicle pushes out so far, because of damp surroundings, that they cannot be handled satisfactorily afterward. Beds should be prepared for them at once. Those about 3 feet in width are best, as they afford opportunity to weed the seedlings without treading on the beds. Such beds made in the Fall, and spread with acorns, the latter covered with 2 inches of soil, should give a treat in the way of seedlings next Spring. Before Winter sets in place a covering of forest leaves over the beds, to keep the acrons free from alternate freezings and thawings.

The first of these early sprouting acorns to ripen is that of the little Chinquapin Oak, *Quercus prinoides.* Next come the two Chestnut Oaks, *Quercus prinus* and *Q. castanea,* followed by the White Oak, *Q. alba.* At this writing, September 28, the *prinoides* and *prinus* are ripe, and the *alba* just about ready to fall from the trees.

QUERCUS—Continued

There is a great call in foreign countries for our White Oak; but between the difficulty of shipping acorns of it in good condition and the embargo placed on plants from this country, the demand cannot be met at all. This, the White Oak, is the most valuable of all our Oaks for timber purposes, although others are valuable and all serve a good purpose for fuel.

CUTTINGS. The evergreen species may be increased by this method.

GRAFTING. *Q. Robur* var. *fastigiata* is grafted on *Q. Robur*, the English Oak, in Winter; on potted plants or on outdoor plants in Spring. In grafting the Oaks choose allied species for stocks.

INARCHING. Varieties inarched on type.

QUINCE. (See Cydonia.)

RAPHIOLEPIS. Indian Hawthorn.

CUTTINGS. Ripe wood under glass late in Summer.

GRAFTING. Used on *Cratægus*.

RASPBERRY. (See Rubus.)

RETINISPORA. (Often spelled Retinospora.)

CUTTINGS. A rapid method, taken in early Winter, placed in greenhouse with a little bottom heat. (See fig. 21.)

Juvenile forms of these Retinisporas are said to be produced by propagating from seedlings and continuing to propagate from the slower growing branches.

GRAFTING. Marinus Van Cleef, in *The Florists' Exchange*, writes "Retinisporas and Thuyas are propagated practically the same way as the Juniper; only they do not require as much care (see Juniperus p. 198), being among the easiest plants to propagate. Excellent success can also be had by the following methods:

Dig up the young wild stock late in the Fall, and heel the plants in a place where the frost cannot touch them, so that when the process of propagating begins in March, they can easily be taken out of the trench. The cions used can be as big as you can get them, and when grafted, they can be placed in the greenhouse very close together. Potting them first is not essential if the work is done this way, and by not doing it you save a lot of trouble and time."

RHAMNUS. Common Buckthorn.

*SEEDS. Stratify in Autumn.

CUTTINGS. Hard wood.

GRAFTING. Some of rarer sorts are grafted on *R. cathartica*.

RHODODENDRON.

SEEDS. The seed is very fine and frequently, falling beneath the old plants, will grow nicely. In the greenhouse they may be sown from January to March in a soil consisting of sand, peat and a little loam. Do not cover, except with a layer of sphagnum, and place a pane of glass over the pots. Immediately upon germination the glass must be removed. *R. ponticum* when used as a stock is raised from seed collected when ripe and hung in a boiler room to dry thoroughly. Crush seed pods with a hammer and sift to get all of the seeds. When the seedlings are up sift some fine sand among them to prevent damping-off. Can be wintered in frames protected in cold weather and aired on warm days. Transplant in June. Trim plants to a single stem.

RHODODENDRON—Continued

CUTTINGS. Half-ripe wood is used and placed in sand benches under glass. When they have callused they may be given a little bottom heat. Heel cuttings will be the best sort to use.

GRAFTING. *R. catawbiense* and *R. maximum* are the best stocks; the Belgian nurseries have been using mostly *R. ponticum*. Veneer grafting is mostly practiced, although cleft and saddle grafting may be used. Let the grafts be made low on the plants. Do not head the stock plant back until the second year. Grafting is done late in Summer, early in Autumn or in December; no wax is used, but the union should be tied with sphagnum; keep the plants in a humid condition and shaded.

Greenhouse Grafting. This is described by Van Cleef in *The Florists' Exchange* of April 28, 1917, as follows:

"The first part of December is the right time to start grafting. Only the youngest shoots of the last Spring's growth can be used for cions. The grafted plants are placed in the greenhouse, in a slanting po ition, with the cion upward. The first four weeks they must not be disturbed, except for a brief airing every morning. Keep the temperature about 70 deg. to 75 deg. F. In four weeks they must be changed around, and a small piece trimmed off the top of the wild stock. Another four weeks' time is needed before the cion is grown on the wild stock, and two more are necessary to harden the plants off, before they can be brought into a warmed frame.

"Rhododendrons grafted in January and February undergo the same treatment in the greenhouse, but do not need a heated frame afterward, because when they are so far advanced that they can be put into the frame, the most severe weather is past. In nice weather the plants must be aired every day.

"All that is left of the wild stock, *Rhododendron ponticum*, must be cut off in March, then the cion starts to grow and gets its first shoot very soon. It is advisable to remove the sashes on a rainy day in April, so they may receive a good natural wetting. Lime must be applied on the sashes when the sun gets stronger. The sashes are removed entirely the first part of May, and for about two weeks it is necessary only to protect the plants from the sun. After two weeks they are ready to be planted out in the nursery as cultivated Rhododendrons.

"They are planted 15 inches to 18 inches apart, because they are going to stay there for three years until ready for shipment. Remove all the growing buds from the tops of the young plants when transferring them from the frame to the field, because that will make new branches sprout from the sides. After planting nothing need be done to them, except to protect them from the sun, which can be done by placing plenty of leafy branches among the plants. Of course weeds should not be allowed to grow, and occasionally the plants must be inspected to see if any insects are appearing. Spray immediately if any appear.

"The followng Spring to make bushy plants, growing buds and flower buds must be removed again, and a little later on the plants must be root-pruned, which is easily done with a little sharp, pointed, handspade. This insures a ball of small fibrous roots. That Fall the Rhododendrons are mostly 18 inches to 24 inches high, well budded, and ready for the market. Most of the Rhododendrons are shipped in Spring, however, but the nurseryman brings all his salable plants together and heels them in near his packing sheds in the Fall, so that when the busy season arrives, the stock is handy and all he has to do is pull it out of the trenches, pack and ship it.

RHODODENDRON—Continued

Grafting in coldframes.

"Briefly, I will explain how Rhododendrons can also be grown in coldframes under double glass in Summer. By double glass I mean an ordinary close fitting coldframe which is made for propagating purposes. Inside of this coldframe another layer of sash is placed, so that plenty of moist heat can be accumulated underneath the lower one.

"The operations involved in growing the wild stock, or *Rhododendron ponticum*, for propagating purposes are of course always the same. Only the stock must be potted late in Spring for Summer propagating. July is the time for grafting and plants receive nearly the same treatment as if grown in the greenhouse in Winter. Only be a little more careful in protecting the plants against the sun, as the leaves soon burn under double glass.

"The first week or so the grafted plants should not be disturbed at all, and afterward the water, which gathers underneath the glass on the inside sashes, should be allowed to run off, by daily lifting the sash for a moment. In about three weeks the plants must be aired a little every morning, and when another week is passed they must be moved, some of the wild stock be cut off, and the new plants replaced in their former position.

"They should now be aired more freely every day, until the cion is grown well onto the wild stock. When the plants are that far advanced all the wild stock can be removed and the plants can be stood in an upright position. The lower sashes are of no more use and can be taken away entirely.

"Leave the plants under single glass for another two weeks, then these sashes can also be taken away. From then on, all they need is protection from the sun, and, when Winter comes to be shielded from snow and frost.

"In Spring these plants can be planted in the nursery, at the same time as the Rhododendrons which are propagated in the greenhouses during the Winter."

LAYERING. Speaking also of Rhododendrons, Van Cleef continues in *The Florists' Exchange*, for May 26, 1917:

"A large percentage of *Rhododendron catawbiense, R. Cunninghami* and several other hardy kinds are produced by layering, as they form roots more quickly by this method.

"In growing Rhododendrons by layering it is advisable to select the stockiest plants obtainable. If large specimens can be obtained they are preferable, as they have many branches that can be used immediately. Plant them with the intention of allowing them to remain in the same place for several years, as parent plants should not be disturbed. Use manure in abundance, and plant at such a distance that the layers do not interfere with each other. Set the parent plants early in the Fall, so that they have a chance to establish themselves thoroughly before Winter comes. It is well to give them a little protection in Winter, by strewing abundant manure around them to protect the roots, and placing boards overhead to guard against frost and early Spring sun. These boards can be removed in the middle of April, as by that time the plants are pretty well used to the sun.

"*Time.* The best time to layer Rhododendrons is in either early Spring or Midsummer, before the sap begins to flow and after the first growth has settled a little. Early Spring is preferable, however, as the layers root more readily when the plant is actively growing, and the soil is usually in a better condition as to moisture. By the time the first growth is settled the weather usually is very hot and the soi l would have to be moistened artificially. One good rain does more goo d than five artificial sprayings.

RHODODHNDRON—Continued

"Before putting in the layers, dig the soil up properly, and mix a good deal of well rotted manure and some peat with it. This can also be done the previous Fall, so that the manure is well rotted when the layering is done. The portion of the branch which goes in the ground should be trimmed of all its leaves. Layering consists in using a young branch of a plant while it is still attached to the parent, by bending it over and placing the middle part of the branch several inches underneath the soil, while the very end of the branch should stay in an upright position, above the soil.

"Forked wooden pegs can be used to secure the branches, after which nature, in many cases, will do the rest by establishing a root system which in time will enable the layer to be separated from the parent, and start life on its own account. In many instances, however, Nature must be assisted, and the starting of the root-growth can be advanced by twisting the branch, by taking off a ring of bark, by tying a thin piece of wire around the branch, by splitting it, or by tonguing. Do not take off too large a piece of bark when making use of that expedient, and when tying a piece of thin wire around the branch take care that it is in the center of the part that is covered by the soil, as roots form at that point.

"When tonguing, a slit is cut in the branch from below upward, making the cut in the center of the branch, so that it is in the middle of the part which is covered with soil. When bending the branch, the incision opens to a certain extent, and when care is taken that the incision is well surrounded by soil, it induces the formation of roots.

"While some kinds of plants root more freely than others, in some cases (especially in woody plants) it takes two years before they have sufficient roots to be transplanted.

"Only a very small part of the end of the branch should be allowed to appear above the soil when the layers are planted. Pinching the buds out of the tops is a great help in making the branches sprout from the sides, and give stocky plants. When an unusually hot, dry Summer prevails and the soil is dry, the layers must be given a thorough soaking occasionally. Always bear in mind that Rhododendrons thrive best in shady, moist places, and in a rich, loose soil."

RHODOTYPOS. White Kerria.

*Seeds. A very free seeder. Even self-sows. Sow when ripened.

Cuttings. Either hard or soft wood. Soft wood in Summer.

RHUS. Sumac. Smoke Tree.

Seeds. Sow in Autumn or stratify, especially of *R. copallina*, *R. glabra*, *R. cotinus*, *R. typhina* and *R. aromatica*.

Cuttings. Hard wood.

Root Cuttings. Especially of *R. typhina* var. *laciniata*, the Fern-leaved Sumac. Cut into three-inch lengths, bury in sand until Spring, then set out in rows.

Layers. Many species may be layered, especially *R. cotinus*.

RIBES. Currant. Gooseberry.

Seeds. Germinate readily.

Cuttings. Hard wood. Make in Autumn. Best method for Currant.

Layers. Mound layers, especially of Gooseberry (see fig. 47.) The varieties may also be tip layered.

Budding and Grafting. Used with horticultural varieties.

When tree or standard plants are wanted, strong stocks, such as *R. aureum*, are used for the Currant, and perhaps *R. rotundifolium*, the Round-leaved Gooseberry, would be useful for the Gooseberry varieties. It is a strong, tall grower.

ROBINIA. Locust.
*SEEDS. Soak in hot water or scald before sowing.
CUTTINGS. Soft wood of *R. hispida* and other species in Summer.
*ROOT CUTTINGS. *R. viscosa* and *R. hispida* especially are propagated by this method.
GRAFTING. *R. hispida* is grafted upon *R. pseudacacia.*

ROMNEYA. Matilija Poppy.
SEEDS. Germinate poorly.
ROOT CUTTINGS.

ROSE. (See pages 85, 161,-169.)

RUBUS. Raspberries.
SEEDS. Grow easily.
DIVISION. Divide clumps for varieties.
ROOT CUTTINGS. Take cuttings three inches long. Good root system by this method.
LAYERS. The red Raspberries are especially easy to tip layer. (See fig. 44.) Pinch out the terminal buds of branches layered and several plants may be obtained instead of one. (See also fig. 103.)

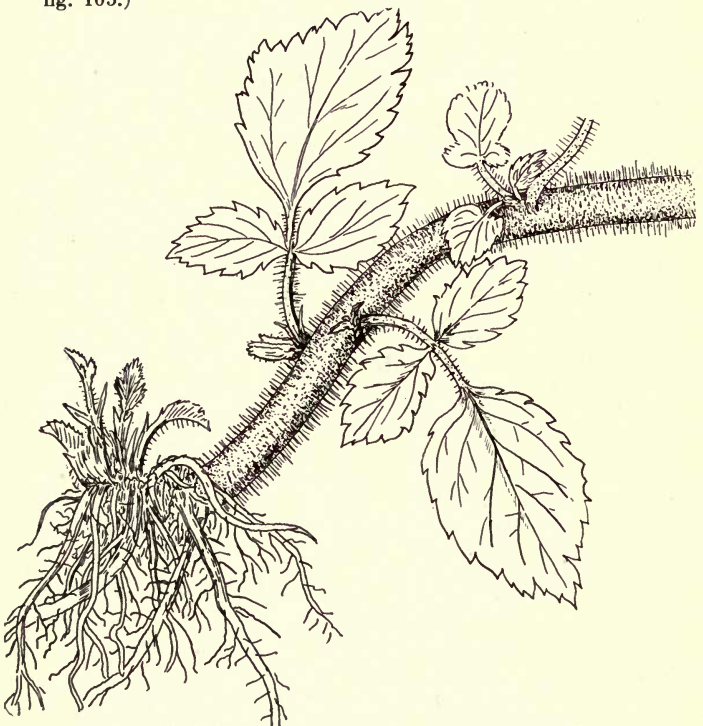


Fig. 103.—Rubus propagation. Shows method of increase. Sketch by George W. Oliver

SALISBURIA. (See Ginkgo.)

SALIX. Willow.

SEEDS. Not used.

*CUTTINGS. Very easily rooted from hard wood cuttings. Set out in Spring. Propagate *S. viminalis*, *S. triandra*, *S. cordata*, and *S. purpurea* (*Forbyana*) for tying nursery stock, some others break instead of bending.

GRAFTING. The Kilmarnock Pussy Willow, a variety of *S. caprea*, is frequently grafted on *S. caprea* to give stronger shoots.

SAMBUCUS. Elderberry.

SEEDS. Grow readily.

*CUTTINGS. Best propagate the Golden Elder by hard wood cuttings, although it comes rather true from seeds. Other species may be rooted from hard or soft wood cuttings also.

ROOT CUTTINGS. Many of the sorts may be propagated by this method.

SUCKER. Readily propagated by this method.

SASSAFRAS.

*SEEDS. Ripen in Autumn; sow immediately or keep in moist earth, sowing in Spring.

SUCKERS. Start when roots are injured.

SCHINUS. Sweet Pepper Tree.

SEEDS. Grow easily.

SCIADOPITYS. Umbrella Pine.

SEEDS. Very slow growing. Seed obtained from Japan.

CUTTINGS. More rapid than seeds but plants are not apt to be symmetrical.

SEQUOIA. (Giant Tree of California.)

SEEDS.

CUTTINGS. (See Thuya, page 217.)

SHEPHERDIA. Buffalo Berry.

SEEDS. Grow readily. As the sexes are distinct, seedling plants must be grown until the sex can be determined. Seedlings are rather sensitive to strong sun.

CUTTINGS.

SKIMMIA.

SEEDS. By seeds both sexed plants are obtained, so that one waits for flowering to determine the berry producers.

CUTTINGS. Produce the plant exactly. Use half-ripe wood under glass.

SOPHORA. Japan Pagoda Tree.

*SEEDS. Germinate readily when fresh.

CUTTINGS. Hard wood or green wood; the latter are best grown from indoor plants.

GRAFTING. Varieties are grafted on seedlings of the type.

SORBUS. Mountain Ash.

SEEDS. Crush fruits and wash out the seeds; sow immediately or store in damp sand until Spring.

GRAFTING AND BUDDING. Varieties are grafted or budded on *S. aucuparia*, *S. americana*, or *Cratægus*.

SPIRÆA. Bridal Wreath and Meadow Sweet.
SEEDS. Many sorts grow nicely from seed especially *S. arguta, S. Billardii, S. salicifolia, S. sorbifolia, S. Thunbergii, S. tomentosa,* and *S. Van Houttei.*
*CUTTINGS. Soft wood cuttings taken in late Spring of some sorts, especially *S. bumalda* var. Anthony Waterer, *S. callosa, S. prunifolia, S. Reevesii, S. rotundifolia* and *S. Thunbergii.* Hard wood cuttings are much used for *S. arguta, S. Billardii, S. Douglassiana, S. rotundifolia, S. salicifolia, S. tomentosa,* and *S. Van Houttei.*
DIVISION. *S. b.* Anthony Waterer is example.
ROOT CUTTINGS. *S. sorbifolia* is propagated in this way.

STAPHYLEA. Bladder Nut.
SEEDS.
CUTTINGS. Young growth placed under glass, or store dormant wood in moss and given bottom heat in March.
ROOT CUTTINGS. Use the larger roots.

STEPHANANDRA.
*CUTTINGS. Green wood used mostly.
ROOT CUTTINGS. *S. incisa* (*flexuosa*) especially. Make cuttings in Spring. Give bottom heat.

STERCULIA. Japan Varnish Tree. Chinese Parasol Tree.
SEEDS. Easily grown if they can be obtained.
CUTTINGS. Soft wood rooted in Summer.
LAYERS.

STEWARTIA.
*SEEDS. Produced abundantly.
CUTTINGS. Difficult to root. Use half-ripened ones.
*LAYERS. Best method. Keep plants low for this.

STIGMAPHYLLON.
CUTTINGS. Soft wood heel cuttings rooted with bottom heat.

STUARTIA. (See Stewartia.)

STYRAX. Storax.
SEEDS. Produced in profusion. Sow as soon as ripe.
CUTTINGS. Do not root well.
LAYERS. Useful.
GRAFTING. Sometimes grafted on *Halesia carolina.*

SYMPHORICARPOS. Indian Currant. Snowberry.
SEEDS. Easy.
*CUTTINGS. Hard wood and green wood.
*UNDERGROUND STEMS. Spread quickly.
SUCKERS. Produced abundantly.

SYMPLOCOS. Sweet Leaf. Horse-Sugar.
SEEDS. Rarely germinate until second year after planting.
CUTTINGS. Under glass. Green wood.

SYRINGA. Lilac.
SEEDS. Raise seedlings for budding. Easily grown.
*CUTTINGS. Green wood in Spring. Place in greenhouse. Good plants are produced by Autumn. Hard wood cuttings are very easily rooted.

SYRINGA—Continued

BUDDING. Budded on *Ligustrum* (California Privet) the plant flowers earlier than when propagated from cuttings. Bud in September, for the sap in Privet is running very late. Such budding also results in dwarfing and less suckering.

LAYERS. Also useful because very sure.

SUCKERS.

TAMARINDUS. Tamarind.

SEEDS. Readily grown from seed sown in hotbed or in greenhouse, with bottom heat.

CUTTINGS. Under glass.

TAMARIX. Tamarisk.

SEEDS. Fine, cover lightly.

*CUTTINGS. Hard wood, use long cutting; plant in open soil in Autumn or Spring. Soft wood in Summer.

LAYERS.

TAXODIUM. Bald Cypress.

SEEDS. Sow in Spring. Germinate quickly.

CUTTINGS. Use young shoots in Summer. Sand and water method should be successful.

GRAFTING. The weeping form, the variegated, and the Oriental species, are grafted on common stock. Grafting in Spring outdoors, near the soil. Shade the cions with paper or flower pot. Or in August the plants may be veneer grafted in greenhouse.

TAXUS. Yew.

SEEDS. Wash seeds free from pulp and keep in damp sand, until Spring.

CUTTINGS. This is the method usually employed. Use green cuttings under glass or mature shoots in Autumn placed in frames. It takes 12 months for some to root.

GRAFTING. *T. cuspidata* is used for all sorts.

LAYERS.

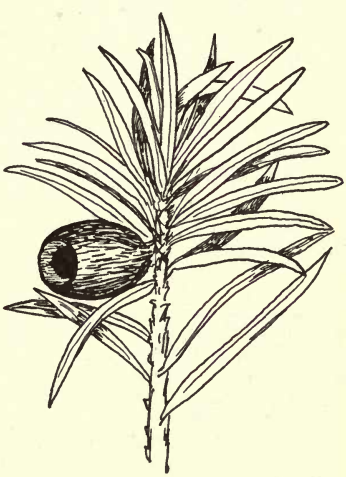


Fig. 101. A Yewberry

TECOMA. (See Campsis.)

THUYA. (Also spelled Thuja). Arborvitæ. White Cedar. (See *Juniperus*, pp. 133, 198, for more extensive notes).

SEEDS. Good for many forms. Sow in Spring. Water frequently. (See p. 45.)

CUTTINGS. For golden form use cuttings made in January. The Siberian Arborvitæ must be propagated by this method as it does not come true from seed. (See p. 73.)

THUYA—Continued

GRAFTING. Pot common Arborvitæ in Autumn, to be used as a stock for *Thuya*, *Thujopsis* and *Retinispora*; keep in cool house until several weeks before grafting. After grafting, keep air of house moist and shade must be given for several weeks. *T. occidentalis* var. *aurea* or George Peabody is grafted on type.

THUJOPSIS.

CUTTINGS. Plants are usually bushy and globular.

GRAFTING. As in Thuya. Plants are not so long lived.

TILIA. Basswood. Linden. Whitewood.

*SEEDS. Sow as soon as ripe or stratify.

LAYERS. Young tree cut down, the resulting growths are layered.

GRAFTED AND BUDDED. Rarer sorts grafted in the Spring, or later; in August, they may be budded on type stock.

Mr. Rehder notes that grafted or layered trees remain one-sided for years because the branches have a tendency to make a horizontal instead of an upright growth.

TORREYA. Stinking Yew.

(See Taxus for propagation.)

TSUGA. Hemlock.

CUTTINGS. Partially ripened wood used.

GRAFTING. Use *T. canadensis* as a stock.

ULEX. Furze. Gorse.

SEEDS. Sown in Spring when frost is past. Bloom in two years.

CUTTINGS. Green or hard wood.

GRAFTING. Grafted in Spring on *U. europæus.*

ULMUS. Elm. (See fig. 105.)

*SEEDS. Sow when ripe. Most Elms ripen seeds in May or June, which germinate in July and August, but *U. parvifolia* ripens its seed in October and November.

CUTTINGS. Hard wood.

GRAFTING. It is best to graft or bud upon allied species. Use *U. americana, U. campestris, U. foliacea* and *U. glabra* as stocks.

The whip and splice graft is mostly used. To obtain the beautiful specimens of the Camperdown or Umbrella Elm, a form of *U. glabra* (*montana*), this sort is grafted on tall stems; at a height of 7 to 8 feet is best, otherwise the mature tree appears dwarfed. This is best done in May. Watch the head for the first few seasons and prune so that it will be well balanced.

UNGNADIA. Mexican Buckeye. Spanish Buckeye

SEEDS. Sow as soon as ripe. They retain their vitality only a short time.

VACCINIUM. Blueberry. Huckleberry.

The notes here offered are a summary of the extensive researches of Dr. Frederick V. Coville.*

STUMPING. The easiest way to propagate the swamp Blueberry is by a special process of layering named "stumping." The directions are as follows:

1. In late Fall, Winter, or Spring, preferably in early Spring before the buds have begun to push, cut off at the surface of the ground either

*Coville, F. V. Directions for Blueberry Culture. Professional Paper Bull. 334, United States Dept. of Agriculture.

Fig. 105. Camperdown Elm. The Camperdown Elm (*Ulmus glabra* var. *Camperdownii*) is either budded or grafted at a height of seven to eight feet upon *U. americana*, *U. campestris*, *U. glabra* or *U. foliacea*

VACCINIUM—Continued

the whole of the plant or as many of the stems as it is desired to devote to this method of propagation. The stems that are cut off are discarded, or they may be used for cuttings, as described under "Tubering" or "Winter cuttings."

2. Cover the stumps to the depth of 2 to 3 inches with a mixture of clean sand and sifted peat, 2 to 4 parts of sand to 1 of peat, by bulk. A rough box or frame may be built on the ground to keep the sand bed in place.

3. Care must be taken that the sand bed be not allowed to become dry except at the surface during the Summer.

VACCINIUM—Continued

4. The new growth from the stumps, which without the sand would consist of stems merely, is transformed in working its way through the sand bed into scaly, erect, or nearly erect rootstocks which, on reaching the surface of the sand, continue their development into leafy shoots. (See fig. 106.) Although roots are formed only sparingly on the covered bases of stems, they develop abundantly during Spring and early Summer on these artificially produced rootstocks, and by the end of Autumn all the shoots should be well rooted at the base. They

Fig. 106. New shoots on a stumped Blueberry. The three shoots shown grew after the plant had been cut to the stump. Their white color at the base indicates the depth of the propagating bed through which they forced their way and from which the plant was taken to be photographed. Roots had already begun to develop. Used through the courtesy of Dr. F. V. Coville of the United States Department of Agriculture

VACCINIUM—Continued

should remain in place in the sand bed till late Winter or early Spring, undisturbed and exposed to outdoor freezing temperatures; but the sand should be mulched with leaves, preferably those of Red Oaks.

5. Early in the following Spring, before the buds have begun to push, open the bed and sever each rooted shoot carefully from the stump. Discard the upper portion of the shoot, making the cut at such a point as to leave on the basal portion about three buds above the former level of the sand bed. If the cut at the basal end of the rooted shoot is not smooth or the wood is cracked, recut the surface with a sharp, thin-bladed knife. The discarded upper portion of the shoot may be used for Winter cuttings.

6. Set the rooted shoots in a coldframe or a cool greenhouse in clean earthenware pots of suitable size, ordinarily 3-inch pots, in a soil mixture consisting of two parts, by bulk, of rotted upland peat and one part of sand.

7. Cover the frame with muslin or other white shade suspended above the glass, giving the plants plenty of light but no direct sunlight, and

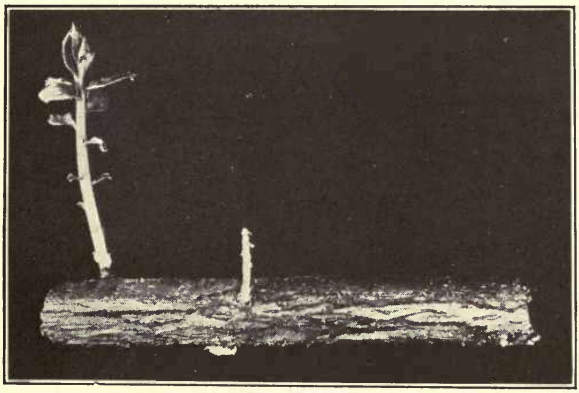


Fig. 107. Tubered Blueberry Cutting with young sprouts developing. Used through the courtesy of Dr. F. V. Coville of the United States Department of Agriculture

for the first two or three months keep the temperature at not to exceed 65 degrees F. if practicable. When subjected to high temperatures the newly cut shoots are liable to die and rot from the base upward. The outer surface of the pots should never be allowed to become dry. The desired condition may be assured by bedding, or "plunging," the pots in moist sand up to the rim.

8. Watering should be as infrequent as practicable, only sufficient to keep the soil moist but well aerated.

9. The frame should receive ventilation, but not enough to cause the new twigs to drop. These are most susceptible to over-ventilation and to over-heating when they have nearly completed their growth.

10. After the new twigs have stopped growing and their wood becomes hard, new root growth takes place. Then secondary twig growth follows, either from the apex of the new twigs or from another bud lower down on the old wood of the original rooted shoot. Until this secondary twig growth takes place the life of the plant is not assured.

VACCINIUM—Continued

11. Those plants that make sufficient growth to require repotting during the first Summer should be set in clean pots of two inches larger diameter in a standard Blueberry soil mixture.

SOIL MIXTURE FOR BLUEBERRIES. Use "one part of clean or washed sand, nine parts of rotted upland peat, either chopped or rubbed through a sieve, and three parts of clean, broken crocks, or flower pots. No loam and especially no lime should be used. Manure is not necessary. The peat most successfully used for potting Blueberry plants is an upland peat procured in Kalmia, or Laurel, thickets. Oak leaves raked, stacked, and rotted for about eighteen months without lime or manure are also good."

TUBERING. Cuttings by ordinary methods have been seldom rooted. Tubering is a method by which new shoots are forced in such a way that their basal portions are much like scaly rootstocks stem.

Cuttings are taken from outdoor plants between Midwinter and early Spring, before the buds have begun to make their Spring growth.

The cuttings are placed horizontally in a shallow box or other cutting bed of pure clean sand and covered to the depth of about half an inch.

Within a few weeks new growth will begin to appear above the sand. (See fig. 107.) When the shoots have reached a length proportionate to their vigor, commonly one to three inches, their further growth is self-terminated by the death of the tip. After the leaves have reached their full size and acquired the dark-green color of maturity the time has come for the development of roots.

When a shoot is well rooted, with roots one to two inches in length, it is ready to be potted. If the shoot has not already disconnected itself from the dead cutting, it should be carefully severed with a sharp knife. In the process of tubering, the behavior of the cuttings is essentially identical with that of real tubers, like those of the potato. The original cutting dies, but the sprouts that arose from it root at the base and form independent plants.

VIBURNUM. Includes Snowball. High Bush Cranberry.

SEEDS. Wash free from pulp; sow in Autumn or mix with dry sand, keep in a cool place and sow in Spring. Especially *V. acerifolium*, *V. cassinoides*, *V. dentatum*, *V. dilatum*, *V. lantana*, *V. lantanoides*, *V. lentago*, *V. molle*, *V. opulus*, *V. opulus nanus*, *V. prunifolia* and *V. americana*.

CUTTINGS. Soft wood in Summer root readily, especially *V. opulus sterilis*, *V. opulus nanus*, *V. tomentosa*, *V. tomentosa sterilis* and *V. plicatum*. Hard wood cuttings are easily rooted.

LAYERS. Early Summer.

VITEX. Chaste Tree. Hemp Bush.

SEEDS. Freely produced.

CUTTINGS. Soft or hard wood; the hard wood cuttings may set in a protected place in the Autumn.

VITIS. Grape.

SEEDS. Rarely come true to type but for raising seedlings of new varieties, the seeds are removed from the pulp and stored in moist sand until Spring when they may be sown in flats or in the open soil. Except those of the tender types, the seeds may benefit by being frozen during the Winter.

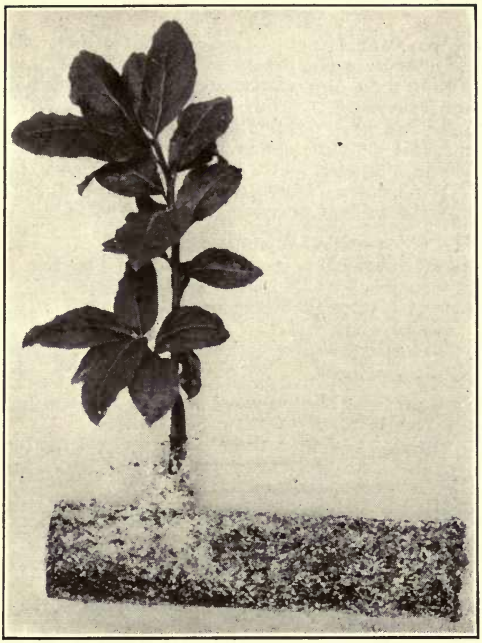


Fig. 108. Tubered Blueberry cutting with sprouts rooting at the base. The sprout at the left in figure 107 had emerged from the sand and begun to develop green leaves above the surface. The sprout near the center of figure 107 is younger, the whole of it still in the rootstock stage. The two sprouts in figure 108 are developing roots on their lower parts, above the dying wood of the old cutting and beneath the surface of the cutting bed. Used through the courtesy of Dr. F. V. Coville of the United States Department of Agriculture

VITIS—Continued

CUTTINGS. Single eye cuttings may be used when wood is scarce, or valuable. A small piece of wood should be left on each side of the eye so that the cutting is about one and a half inches long. These cuttings are made in February from wood stored through the Winter in a cool cellar. They are placed in propagating bench with slight bottom heat. The best wood for use in making cuttings is that which is rather short jointed. The most common type of cutting, however, is five to seven inches long, made in the Autumn and stored in a sandy soil out of doors or in a cool cellar. They are placed up-side down to hasten the callus. In the Spring the cuttings are set in the nursery row.

GRAFTING. Grapes are grafted in earliest Spring or Autumn. The soil around the plants is removed and the cion is inserted beneath the soil. Merely tie with raffia. If grafting has been neglected

VITIS—Continued

until the sap flows, the stocks may be grafted after the buds burst. This will eliminate the excess bleeding. The European Grape is usually grafted on American stocks because of its susceptibility to root louse injury. After grafting very early in Spring or in Autumn Mr. Fuller* suggests protecting the cion from frost by covering with an inverted flower pot and straw.

LAYERS. The simplest method of propagating is by continuous layers. Bend down a cane and cover a few inches deep with soil. Nearly all the nodes will root. Practiced in Autumn or Spring.

WISTARIA. (Also spelled Wisteria.)

SEEDS. Grow readily but do not reproduce varieties.
CUTTINGS. Ripened wood rooted under glass.
ROOT CUTTINGS. One inch or more long.
LAYERS. Easily rooted.
GRAFTING. Horticultural varieties grafted on *W. frutescens.*

XANTHOCERAS.

SEEDS. Few produced but usually all grow if sown in greenhouse or stratified over Winter.
ROOT CUTTINGS. Cut into three-inch pieces in Autumn and store in sand until February, then place where they may start into growth with a light bottom heat.

XANTHORRHIZA. Shrubby Yellow-Root. (Also spelled Zanthorrhiza.)

SEEDS. Sow in Autumn or early Spring. Seedlings are weak when young.
ROOT DIVISIONS. In Autumn or Early Spring.

XANTHOXYLUM. Prickly Ash. Toothache Tree. (Also spelled Zanthoxylum.)

SEEDS.
ROOT CUTTINGS. Easiest method.

YUCCA.

SEEDS. Flower in 5-6 years.
OFFSETS. Flower in three years.
ROOT CUTTINGS. Cut up thick roots into two-inch pieces, place one to two inches deep.

ZELKOVA. Siberian Elm.

LAYERS.
GRAFTING. Use Elm as stock.

* Fuller. A. S.—Grape Culturist.